LOUISIANA
STANDARD SPECIFICATIONS
FOR
ROADS AND BRIDGES

1977
EDITION

STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION
AND DEVELOPMENT

OFFICE OF HIGHWAYS
Baton Rouge

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PART I

GENERAL PROVISIONS

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Definitions and Terms

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

Wherever the abbreviation "LDH" or the term "Louisiana Department of Highways" appears in the plans, project specifications or other contract documents, it shall be interpreted to mean the Louisiana Department of Transportation and Development, Office of Highways.

Wherever the term "Director" appears in the plans, project specifications or other contract documents, it shall be interpreted to mean the Assistant Secretary for the Office of Highways, Louisiana Department of Transportation and Development.

101.01 ABBREVIATIONS. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ARA	American Railway Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
DOTD	Department of Transportation and Development (Louisiana)

FHWA-DOT	Federal Highway Administration, Department of Transportation
FSS	Federal Specifications and Standards, General Services Administration
IPCEA	Insulated Power Cable Engineers Association
MUTCD (LA)	Manual on Uniform Traffic Control Devices (Louisiana)
NEMA	National Electric Manufacturers Association
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratories, Inc.

101.02 ACCESS CONNECTION. Any roadway facility by means of which vehicles can enter or leave a highway. Included are intersections at grade, private driveways, and ramps or separate lanes connecting with cross streets or frontage roads.

101.03 ADVERTISEMENT. A public announcment inviting bids for work to be performed or materials to be furnished.

101.04 ARTERIAL HIGHWAY. A general term denoting a highway primarily for through traffic, usually on a continuous route.

101.05 AUXILIARY LANE. The portion of the roadway adjoining the traveled way for parking, speed-change or for other purposes supplementary to through traffic movement.

101.06 BASE COURSE. The layer or layers of specified material of designed thickness on a subbase or a subgrade to support a surface course.

101.07 BIDDER. An individual, partnership, corporation, joint venture or any acceptable combination thereof submitting a bid proposal.

101.08 BRIDGE. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, which has a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes; may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Length: The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of bridge floor.

Bridge Roadway Width: The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

101.09 CALENDAR DAY. Every day shown on the calendar, beginning and ending at midnight.

101.10 CHANGE ORDER. A written order to the contractor, approved by the engineer, covering changes in the plans, quantities or both within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes. Also refer to Subsection 101.42.

101.11 CONTRACT. The written agreement between the Department and the contractor setting forth the obligations of the parties thereunder.

The contract includes the invitation for bids, proposal, contract form and contract bond, specifications, supplemental specifications, special provisions, general and detailed plans, and notice to proceed, also any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

101.12 CONTRACT BOND. The approved form of security, executed by the contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

101.13 CONTRACT ITEM (Pay Item). A specific unit of work for which a price is provided in the contract.

101.14 CONTRACT TIME. The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

If a calendar date of completion is shown in the proposal, in lieu of a number of working or calendar days, such work contemplated shall be completed by that date.

101.15 CONTRACTOR. The individual, partnership, firm, corporation, joint venture or any acceptable combination thereof, contracting with the highway agency for performance of prescribed work.

101.16 CONTROLLED ACCESS HIGHWAY. Any highway, to or from which access is denied or controlled, in whole or in part, from or to abutting land or intersecting streets, roads, highways, alleys or other public or private ways.

101.17 CONTROL OF ACCESS. The condition where the right of owners or occupants of abutting land or other persons to access, light, air or view in connection with a highway is fully or partially controlled by public authority.

Full Control: Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

Partial Control: Partial control of access means that the authority to con-

trol access is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

101.18 CONTROLLING ITEMS OF WORK. The items of construction that should be in progress at the time, as essential to the orderly completion of the work within the time limit specified, in accordance with the contractor's approved progress schedule. Refer to Subsections 104.02 and 108.03.

101.19 CULVERT. Any drainage structure under the roadway not defined as a bridge.

101.20 DEPARTMENT. The Department of Transportation and Development of the State of Louisiana, constituted under the laws of the State for the administration of highway work.

101.21 DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT. The Department of Transportation and Development of Louisiana, through its offices and officers, responsible for developing and implementing programs to assure adequate, safe, and efficient transportation and other public works facilities and services in the state in accordance with Act 513 of the 1976 regular session of the State Legislature.

The Department of Transportation and Development shall be composed of the Office of the Secretary, the Office of Management and Finance, the Office of Aviation, the Office of Highways, the Office of Public Transit, the Office of Public Works, the Mississippi River Bridge Authority, and such other offices as shall be created by law.

Officers of the Department of Transportation and Development for secretary, deputy secretary, under secretary and assistant secretary for Office of Highways are as follows:

(a) Secretary. Executive head and chief administrative officer of the Department of Transportation and Development.

(b) Deputy Secretary. The principal administrative assistant to the "Secretary."

(c) Undersecretary. The principal officer of the Office of Management and Finance of the Department of Transportation and Development.

(d) Assistant Secretary. The principal officer of the Office of Highways of the Department of Transportation and Development.

101.22 DIVIDED HIGHWAY. A highway with separated roadways for traffic in opposite directions.

101.23 ENGINEER. The Chief Engineer of the Department, acting directly or through his duly authorized representatives, who is responsible for engineering supervision of the construction. When the term "Chief Engineer" is used, it shall mean the chief engineer in person.

101.24 EQUIPMENT. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.25 EXPRESSWAY. A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

101.26 EXTRA WORK. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

101.27 FLUME. A structure used primarily for the passage of irrigation water.

101.28 FREEWAY. An expressway with full control of access.

101.29 GRADE SEPARATION. A crossing of two highways, or a highway and a railroad, at different levels.

101.30 HIGHWAY, STREET OR ROAD. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. Recommended usage in urban areas—highway or street; in rural areas—highway or road.

101.31 INSPECTOR. The engineer's authorized representative assigned to make detailed inspections of contract performance.

101.32 INTERCHANGE. A grade-separated intersection with one or more turning roadways for travel between intersecting legs.

101.33 INVITATION FOR BIDS. The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

101.34 LABORATORY. The testing laboratory of the Department or any other approved testing laboratory which may be designated by the engineer.

101.35 LOCAL STREET OR LOCAL ROAD. A street or road primarily for access to residence, business or other abutting property not in State maintained system.

101.36 MAJOR STREET OR MAJOR ROAD. An arterial highway with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.

101.37 MATERIALS. Any substances specified for use in the construction of the project and its appurtenances.

101.38 MEDIAN. The portion of a divided highway separating the traveled ways for traffic in opposite directions.

101.39 NOTICE TO PROCEED. Written notice to the contractor to proceed with the contract work, including the date of beginning of contract time.

101.40 PARISH. The parish in which the specified work is to be done.

101.41 PAVEMENT STRUCTURE. The combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.42 PLAN CHANGE AND/OR SPECIAL AGREEMENT. A change order concerning the performance of work or furnishing of materials involving extra work. Such extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications. Also refer to Subsection 101.10.

101.43 PLANS. The contract drawings which show the location, character, and dimensions of the prescribed work, including layouts, profiles, cross sections and other details.

Standard Plans—Drawings approved for repetitive use, showing details to be used where appropriate.

Working drawings—Supplemental design sheets or similar data which the contractor is required to submit to the engineer such as stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans and bending diagrams for reinforcing steel.

101.44 PROFILE GRADE. The trace of a vertical plane intersecting the top surface of the proposed wearing surface or other designated course usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.45 PROJECT. The specific section of the highway together with all appurtenances and construction to be performed thereon under the contract.

101.46 PROJECT ENGINEER. The engineer assigned to one or more specified construction projects to represent the Department through the Chief Engineer.

101.47 PROJECT NUMBER. A number used for convenience to describe and delineate certain construction within definite geographical limits.

101.48 PROPOSAL. The offer of a bidder, on the prescribed form, to perform the stated work and to furnish the labor and materials at the prices quoted.

101.49 PROPOSAL FORM. The prescribed form on which the offer of a bidder must be submitted.

101.50 PROPOSAL GUARANTY. The required security furnished with a bid proposal.

101.51 QUALIFIED PRODUCTS LISTS. Lists which are maintained by the Department's Materials Section for products which do not lend themselves to the preparation of meaningful specifications, or for which repetitive full testing is too time consuming or expensive to be practical for routine project control.

Qualification of a product is not blanket approval for its use, since qualified products are subject to certification and/or acceptance or verification testing as outlined in the Department's Materials Sampling Manual.

101.52 QUESTIONNAIRE. The specified forms on which the contractor shall furnish required information as to his ability to perform and finance the work.

101.53 RIGHT-OF-WAY. A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway.

101.54 ROADBED. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder.

101.55 ROADSIDE. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.56 ROADSIDE DEVELOPMENT. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seedings, sodding, mulching and the placing of other ground covers; such as suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.57 ROADWAY. In general that portion of a highway, including shoulders, provided for vehicular use. A divided highway has two or more roadways. In construction specifications, a roadway is that portion of a highway within the limits of construction.

101.58 SERVICE ROAD OR FRONTAGE ROAD. A local street or road auxiliary to and located on the side of the roadway for service to abutting property and adjacent areas and for control of access.

101.59 SHOULDER. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and/or for lateral support of base and surface courses.

101.60 SIDEWALK. That portion of the roadway primarily constructed for the use of pedestrians.

101.61 SPECIAL PROVISIONS. Additions and revisions to the standard and supplemental specifications covering conditions applicable to the project.

101.62 SPECIFICATIONS. The compilation of provisions and requirements for the performance of prescribed work.

Standard Specifications—a book of specifications for general application and repetitive use.

Supplemental Specifications—Additions and revisions to the Standard Specifications.

Project Specifications—All Standard Specifications, Supplemental Specifications, Special Provisions and other provisions that are applicable to the project.

101.63 STATE. The State of Louisiana, acting through its authorized representative.

101.64 STRUCTURES. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

101.65 SUBBASE. The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

101.66 SUBCONTRACTOR. An individual, partnership, firm, corporation, joint venture or any acceptable combination thereof, to which the contractor sublets part of the contract.

101.67 SUBGRADE. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.68 SUBSTRUCTURE. All of that part of the structure below the bearings of simple and continuous spans, skewbacks or arches and tops of footings of rigid frames, including backwalls, wingwalls and wing protection railings.

101.69 SUPERINTENDENT. The contractor's authorized representative in responsible charge of the work.

101.70 SUPERSTRUCTURE. The entire structure except the substructure.

101.71 SUPPLEMENTAL AGREEMENT. A written agreement made and entered into by and between the contractor and the Department covering work not otherwise provided for, revisions in or amendments to the terms of the contract or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreement becomes a part of the contract when approved and properly executed.

101.72 SURETY. The corporation, partnership or individual, other than the contractor, executing a bond furnished by the contractor.

101.73 SURFACE COURSE. One or more layers of a pavement structure designed to accommodate the traffic load, the top of which resists skidding, traffic abrasion, and the disintegrating effects of climate.

101.74 TITLES (Or Headings). The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.75 THROUGH AND LOCAL TRAFFIC.

(a) Through traffic is that traffic which has neither its origin nor its destination within the limits of the project.

(b) Local traffic is that traffic which has either its origin or its destination within the limits of the project.

101.76 THROUGH STREET OR THROUGH HIGHWAY. Every highway or portion thereof on which vehicular traffic is given preferential right-of-way, and at the entrances to which vehicular traffic from intersecting highways or streets is required by law to yield right-of-way to vehicles on such through highway in obedience to either a stop sign or a yield sign, when such signs are erected.

101.77 TRAFFIC LANE. The portion of traveled way for the movement of a single land of vehicles.

101.78 TRAVELED WAY. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.79 WORK. The furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all duties and obligations imposed by the contract.

101.80 WORKING DAY. A calendar day, with the exceptions stated herein, on which weather and other conditions not under control of the contractor will permit construction operations to proceed for at least five continuous hours of the day with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time.

No working days will be charged for the days listed below, except as specified by the succeeding paragraph:

(1) Saturdays and Sundays.

(2) State recognized holidays that are defined as regular legal holidays or special holidays that may be proclaimed by the Governor or fixed by the Legislature.

(3) Days on which delays, attributable solely to the Department or other governmental agencies, prevent contractor from proceeding with the controlling item(s) of work in effect at time of delay.

(4) Days on which delays are attributable to the direct effect of strikes, riots or civil commotions.

If the contractor performs work which requires engineering layout, supervision or inspection on Saturday, Sunday or a State recognized holiday, a

working day will be charged regardless of the size of the working force or the number of hours worked. Any work done in connection with the continuing of curing, loading of test piles, watering of sod, etc., as is required by the specifications, is excluded from the work defined by this paragraph and a working day will not be charged if this is the only work performed.

101.81 WORK ORDER. See "Notice to Proceed" Subsection 101.39.

101.82 In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be done, if, as, or, when or where "contemplated, required, determined, directed, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected or condemned," it shall be understood as if the expression were followed by the words "by the engineer" or "to the engineer."

Section 102

Bidding Requirements and Conditions

102.01 PREQUALIFICATION OF BIDDERS. To qualify for submission of a bid, the bidder shall comply with all rules and regulations of the Louisiana State Licensing Board for Contractors in accordance with existing State laws.

102.02 CONTRACTORS LICENSING LAWS. Attention is directed to the rules and regulations of the State Licensing Board for Contractors in accordance with Louisiana Revised Statutes 37:2151-2163. Information relative to licensing may be obtained from the offices of said Board in Baton Rouge.

If the estimated project cost is $30,000 or more, only licensed contractors may receive bid forms, unless Federal funds are involved. When Federal funds are involved, nonlicensed contractors may receive bid forms and submit bids; however, if the estimated project cost is $30,000 or more, the successful nonlicensed bidder will be required to obtain the proper license before beginning work under the contract.

102.03 CONTENTS OF PROPOSAL FORMS. Upon request, the Department will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished and will have a schedule of items for which unit bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time and place of the opening of proposals. The form will also include any project specifications or requirements which vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder will be required to pay the Department the sum stated in the notice to contractors for each set of plans.

102.04 ISSUANCE OF PROPOSALS. The Department will refuse to issue a proposal to a bidder for any of the following reasons.

(1) Failure to comply with the prequalification requirements of the Department.

(2) Disqualification in accordance with Subsection 108.04.

(3) Failure to satisfactorily settle all bills due for labor and material on previous contracts in force at the time proposals are issued.

(4) In default of a contract resulting in the contract currently being completed by others.

102.05 INTERPRETATION OF QUANTITIES IN BID SCHEDULE. The quantities appearing in the bid schedule are prepared for the comparison of bids and may be approximate. Payment to the contractor will be made in accordance with the measurement and payment requirements for bid items and other requirements of the project specifications. The bid item quantities may be increased, decreased or omitted as provided in these specifications.

102.06 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE OF WORK. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, project specifications and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, project specifications and contract forms.

Any pre-bid test and boring data in connection with subsurface conditions which have been compiled by the Department and furnished the contractor at his request shall not be considered as fully representative of actual subsurface conditions existing throughout the area tested nor shall they in any way be binding upon the Department; it being understood that said data will be furnished the contractor for his convenience only and the contractor shall be solely responsible for conducting his own boring explorations which he may deem necessary in preparing his bid.

No claim shall be made against the Department for any additional compensation incurred as a result of unforeseen subsurface conditions arising during the progress of the work and which might be in variance with the Department's pre-bid boring data.

102.07 PREPARATION OF PROPOSAL. The bidder shall submit his proposal on the forms furnished by the Department. The bidder shall specify a unit price in words and figures for each pay item or alternate pay item for which a quantity is given and shall also show the products of the respective unit prices and quantities written in figures in the column provided for that purpose. All the words and figures shall be in ink or typed. In case of a discrepancy between the prices written in words and those written in

figures, the prices written in words shall govern. When special forms are included in the proposal for Items 202(2), 710(1), 710(2) or 710(3), the unit bid prices for these items shall be specified in figures.

The proposal must be signed with ink by the individual; or by one or more members of the partnership; or by one or more members or officers of each firm representing a joint venture; or by one or more officers of a corporation; or by an agent of the contractor legally qualified and acceptable to the state. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firm represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

102.08 IRREGULAR PROPOSALS. Proposals will be considered irregular and will be rejected for any of the following reasons:

(1) If the proposal is on a form other than that furnished by the Department or if the form is altered or any part thereof is detached.

(2) If there are unauthorized additions, conditional or alternate bids or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.

(3) If the bidder adds any provisions reserving the right to accept or reject the award or to enter into the contract pursuant to the award.

(4) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

(5) If the proposal is submitted as a bid by a bidder other than the one to whom the proposal was originally issued.

(6) If an owner or a principal officer of the bidding firm is an owner or a principal officer of a contracting firm which has been declared by the Department to be ineligible to bid.

(7) If the proposal guaranty does not meet requirements of Subsection 102.09.

(8) If more than one proposal for the same work is received from an individual, partner, firm, corporation, joint venture or combination thereof under the same or a different name.

102.09 PROPOSAL GUARANTY. Each bid must be accompanied by a proposal guaranty in an amount not less than the amount specified in the advertisement for bids. The proposal guaranty shall be either a check certified by the cashier of a National or State Bank located in the State of Louisiana or a bid bond guaranteed by a surety company qualified to do business in the State of Louisiana. The certified check or bid bond shall be made payable to the Department of Transportation and Development, Office of Highways. A cashier's check, money order or currency will not be accepted.

If the proposal guaranty submitted by a bidder is in the form of a bid bond, this bond must be similar in all respects to the form of the "Bid or Proposal Bond" sheet included in the proposal. The bid bond must be filled out in dollars and cents; must be signed by the authorized officer, owner or partner of the bidding firm, or each firm representing a joint venture; and must be signed by the surety's agent or attorney-in-fact. If the surety's signer is not an authorized licensed resident agent in accordance with existing State laws, the bond shall be countersigned by a licensed resident agent authorized by the Louisiana Commissioner of Insurance to sign on behalf of the surety. The bond shall be accompanied by a notarized document granting general power of attorney to the surety's signer.

102.10 DELIVERY OF PROPOSALS. Each proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its content. When an envelope other than the special one furnished by the Department is used, it shall be the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the notice to contractors. Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.11 WITHDRAWAL OR REVISION OF PROPOSALS. A bidder may withdraw or revise a proposal after it has been deposited with the Department provided the request for such withdrawal or revision is received by the Department, in person or in writing or by telegram, before the time set for opening proposals.

102.12 COMBINATION OR CONDITIONAL PROPOSALS. If the Department so elects, proposals may be issued for projects in combination or on separate units of the combination. The Department reserves the right to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids other than those specifically set up in the proposals by the Department will be considered. Separate contracts will be written for each individual project included in the combination.

Conditional proposals will be considered only when so stated in the project specifications.

102.13 PUBLIC OPENING OF PROPOSALS. Proposals will be opened and read publicly at the time and place indicated in the notice to contractors. Bidders, their authorized agents and other interested parties are invited to be present.

102.14 MATERIAL GUARANTY. The successful bidder may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

Section 103

Award and Execution of Contract

103.01 CONSIDERATION OF PROPOSALS. After the proposals are opened and read, they will be compared on the basis of the summation of the products of the quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals if, in the judgment of the awarding authority, the best interests of the Department will be promoted thereby.

103.02 AWARD OF CONTRACT. The award of contract, if it be awarded, will be made within 30 calendar days after the opening of proposals to the lowest responsible and qualified bidder whose proposal complies with all the requirements prescribed. The successful bidder will be notified by letter mailed to the address shown on his proposal that his bid has been accepted and that he has been awarded the contract.

103.03 CANCELLATION OF AWARD. The Department reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Department.

103.04 RETURN OF PROPOSAL GUARANTY. All proposal guaranties of unsuccessful bidders will be returned to them within 15 days after the opening of the bids. The retained proposal guaranty of the successful bidder will be returned after a satisfactory bond has been furnished and the contract has been executed.

103.05 REQUIREMENT OF CONTRACT BOND. At the time of the execution of the contract, the successful bidder shall furnish a surety bond or bonds in a sum equal to the full amount of the contract. The form of the bonds and the security shall be acceptable to the Department.

103.06 EXECUTION AND APPROVAL OF CONTRACT. The contract shall be signed by the successful bidder and returned, together with the contract bond, within 15 days after the contract has been mailed to the bidder. If the contract is not executed by the Department within 15 days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been fully executed by all of the parties thereto.

103.07 FAILURE TO EXECUTE CONTRACT. Failure to execute the contract and file acceptable bond within 15 days after the contract has been mailed to the bidder may be cause for cancellation of the award and forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty, but in liquidation of damages sustained. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract, as the Department may decide.

103.08 FAILURE TO ISSUE NOTICE TO PROCEED. Should the "Notice to Proceed" not be issued within 6 months after the execution of the contract, the contractor may at any time thereafter demand cancellation of the contract prior to issuance of "Notice to Proceed."

Section 104

Scope of Work

104.01 INTENT OF CONTRACT. The intent of the contract is to provide for the construction and completion in every detail of the work described. The contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

When an item in the proposal and contract contains a choice to be made by the contractor as to the type material to be furnished, the contractor, before the work is initiated, shall indicate his choice in accordance with the specifications for that item. Such notification shall be submitted to the engineer in writing.

104.02 ALTERATION OF PLANS OR CHARACTER OF WORK. The Department reserves the right to make, at any time during the progress of the work, such increases or decreases in quantities and such alterations in the work within the general scope of the contract, including alterations in grade or alinement of the road or structure or both, as deemed necessary or desirable. Such increases or decreases and alterations shall not invalidate the contract nor release the surety, and the contractor agrees to accept the work as altered, as if it has been a part of the original contract.

Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as necessary to satisfactorily complete the project.

Unless such alterations and increases or decreases materially change the character of the work to be performed or the cost thereof, the altered work will be paid for at the same unit prices as other parts of the work. If, however, the character of the work or the unit costs thereof are materially changed, an allowance shall be made on such basis as may have been agreed to in advance of the performance of the work, or in case no such basis has been previously agreed upon, an allowance will be made, either for or against the contractor, in such amount as the engineer deems equitable.

No claim shall be made by the contractor for any loss of anticipated profits because of any such alteration or by reason of any variation between the approximate quantities and the quantities of work as done.

If the altered or added work is of sufficient magnitude to require additional

time in which to complete the project, such time adjustment may be made in accordance with the provisions of Subsection 108.07.

If alteration of plans or character of work as defined in this Subsection results in an increase or decrease of more than 25 percent in the quantity stated in the proposal for any major item of the contract that is not covered by a Plan Change and/or Special Agreement signed by the contractor, a supplemental agreement to the contract may be executed between the Department and the contractor at the request of either party, prior to performance of any additional work in excess of 25 percent of the contract quantity, and when a supplemental agreement is executed, the consent of the contractor's surety shall be obtained.

If demand is made for a supplemental agreement, any adjustment in unit price will be made on only that portion of the major item that exceeds the 25 percent increase or decrease, and such adjustment will be made based on the actual costs to perform that portion of the work in excess of the 25 percent increase or decrease of the proposed quantity.

A "Major Item" is defined as an item included in the proposal that has a total cost equal to or greater than 10 percent of the amount of the contractor's total original bid.

A "Minor Item" is defined as an item included in the proposal that has a total cost of less than 10 percent of the amount of the total original bid. A minor item shall become a major item if it is increased by such an amount that its total cost is equal to or greater than 10 percent of the contractor's total original bid. When a minor item is increased to the extent that it becomes a major item, only that part of the item that exceeds 12.5 percent of the contractor's original bid will be considered on any supplemental agreement executed.

The total cost of any item will be considered as the product of the quantity of work shown in the proposal for that item and the contractor's bid price for the item, except in the case of an increase in a minor item as provided in the preceding paragraph.

104.03 EXTRA WORK. The contractor shall perform unforeseen work for which there is no price included in the contract whenever it is deemed necessary or desirable in order to complete the work as contemplated. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as provided under Subsection 109.04.

104.04 MAINTENANCE OF TRAFFIC. Reasonable provisions for local traffic throughout the length of the project and the life of the contract must be made by the contractor, at his own expense, during construction.

When specified, the contractor may also be required to provide for through traffic, at his own expense, over the entire project or any designated portion thereof.

The contractor shall keep the portion of the project being used by public traffic, whether it be through or local traffic, in such condition that traffic will be adequately accommodated. He shall furnish, erect and maintain barricades, warning signs, delineators, flagmen and pilot cars in accordance with the plans and the MUTCD(LA). He shall also provide and maintain in a safe condition all required temporary approaches or crossings, intersections with roads, streets, businesses, parking lots, residences, garages and farms. The contractor shall bear all expense of maintaining traffic and of contructing and maintaining such approaches, crossings, intersections and other features as may be necessary, without direct compensation, expect as provided in the project specifications.

If the engineer directs additional measures for the benefit of the traveling public, the contractor will be paid therefor at unit prices in the contract or as provided in Subsection 104.03. The engineer will be the judge of work to be classed as additional measures.

104.05 USE OF MATERIALS FOUND ON THE WORK. The contractor, with written approval of the Chief Engineer, may use on the project such stone, gravel, sand, topsoil or other material determined acceptable by the engineer as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. The contractor shall replace at his own expense with acceptable material all of that portion of the removed material which was needed for embankments, backfills, approaches or otherwise. No charge for the materials so used will be made against the contractor. The contractor shall not excavate nor remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the engineer. If authorization is obtained, payment will not be made for excavation beyond the minimum slope and grade lines.

Materials from existing structures may be used temporarily by the contractor in the erection of new structures. Modification of such material will not be permitted except with the approval of the engineer.

104.06 FINAL CLEANING UP. Before final acceptance, the highway right-of-way, borrow and local material sources and all areas occupied by the contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, haul roads and equipment; and all parts of the work, including private property adjacent to the right-of-way, which have been damaged or rendered unsightly during the work shall be left in a neat and presentable condition acceptable to the engineer, and if required, the right-of-way shall be mowed; all at no cost to the Department.

Section 105

Control of Work

105.01 AUTHORITY OF THE ENGINEER. The engineer will decide all questions which arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the contractor.

The engineer will have the authority to suspend the work wholly or in part due to failure of the contractor to correct conditions unsafe for workmen or the general public; for failure to carry out provisions of the contract; for failure to carry out orders; for such periods as he may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

All orders to suspend the work will be in writing and will include the specific reasons for the suspension. The order to resume work will also be in writing.

105.02 PLANS AND WORKING DRAWINGS. Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures and a summary of items appearing in the proposal. Only general features will be shown for steel bridges. The contractor shall keep one set of plans available on the work at all times.

Working drawings for structures shall be furnished by the contractor and shall consist of such detailed plans as required to adequately control the work and are not included in the plans furnished by the Department. They shall include stress sheets, shop drawings, erection plans, falsework plans, form drawings, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data required of the contractor. All working drawings must be approved by the engineer and such approval shall not relieve the contractor of any of his responsibility under the contract for the successful completion of the work or of his responsibility for the details shown in the working drawings to conform in all respects to the contract plans except where changes have been approved by the Chief Engineer or his authorized representative.

The type and size of drawings furnished shall be as described in Subsection 801.03.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements shown on the plans or indicated in the specifications.

If the engineer finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall make a determination if the work will be accepted and remain in place. In this event, the engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary.

If the engineer finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the contractor.

Partial pay schedules will be used when such schedules are a part of the specifications.

105.04 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS. These specifications, the supplemental specifications, the plans, special provisions and all supplementary documents are essential parts of the contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; plans will govern over standard specifications or supplemental specifications; supplemental specifications will govern over standard specifications; special provisions will govern over standard specifications, supplemental specifications and plans.

The contractor shall take no advantage of any apparent error or omission in the plans or specifications. If the contractor discovers such an error or omission, he shall immediately notify the engineer. The engineer will then make such corrections and interpretations as deemed necessary to fulfil the intent of the plans and specifications.

105.05 COOPERATION BY CONTRACTOR. The contractor will be supplied without charge a maximum of 5 sets of approved plans and contract assemblies including project specifications for each contract. Half scale plans will be furnished unless full scale plans are requested. The contractor shall keep one complete set of the plans and contract documents available on the work at all times.

The contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the engineer, his inspectors and other contractors in every way possible.

The contractor shall have on the work at all times, as his agent, a competent superintendent capable of reading and understanding the plans and specifications and experienced in the type of work being performed, who shall receive instructions from the engineer or his authorized representatives. The superintendent shall have authority to execute orders or directions of the engineer without delay and to promptly supply such materials, equipment, tools, labor and incidentals as required. Such superintendence shall be furnished regardless of the amount of work sublet.

The contractor shall certify to the engineer, by written notice, the names of persons authorized to sign for him in all matters pertaining to the changing of plans, force account or extra work, contract time charges and other fiscal documents. No work shall commence on the project until the contractor has complied with this requirement. Such written notice shall also be furnished at any time a person so designated is removed and replaced on the project.

105.06 COOPERATION WITH UTILITIES. The Department will notify all utility companies, pipe line owners or other parties affected and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines and other appurtenances within or adjacent to the limits of construction made as soon as possible.

Upon award of the contract, utility companies affected will be advised by the Department of the name and address of the contractor, the approximate date work will begin and other pertinent information.

Except as hereinafter provided, and regardless of whether the utility is shown on the plans or referred to in the project specifications, all water lines, gas lines, wire lines, service connections, water and gas valve boxes, light standards, cableways, signals and other utility appurtenances within the limits of construction which conflict with and prevent completion of the contractor's work are to be relocated or adjusted by the owners through negotiations with the Department at no expense to the contractor.

Where a utility crosses or otherwise occupies an area within the construction limits of the project and the utility will not have the Department's required clearance when the work is completed, it shall be the Department's responsibility to arrange for necessary relocation to the required clearance, at no expense to the contractor. If the required clearance will exist when the work is completed, the contractor shall at his own expense, make arrangements with the owner for any relocation or adjustment he considers necessary to his operations. In such cases, upon completion of the work and prior to final acceptance, the final location of the utility must be acceptable to the Department. Nothing in these requirements shall be interpreted directly or by implication, to mean that the Department waives any of its rights to control

the entrance onto, or location on, its right-of-way, of any utility or appurtenance.

It is understood and agreed that the contractor has considered in his bid all the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them.

In general, the contract will indicate any utility items which are to be relocated, adjusted or constructed by the contractor. The project specifications will indicate the means of adjudication, if any, in case of failure by the utility owner to comply with their responsibility in relocating or adjusting their facilities.

If the engineer determines that the contractor is experiencing significant delays in the controlling item(s) of work because of the delays by others in removing, relocating or adjusting utility appurtenances, contract time credits will be considered for such delays.

On the date stipulated in the "Notice to Proceed," the contractor shall begin work in connection with fencing, clearing, grubbing, removal of structures and obstructions, and relocation and demolishing of buildings and other structures, and shall prosecute such work to completion to avoid delays in removal or adjustment of utilities. The contractor shall cooperate with officials of utility companies to avoid delays in completion of work due to nonremoval or nonadjustment of utilities.

105.07 COOPERATION BETWEEN CONTRACTORS. The Department reserves the right at any time to contract for and perform additional work on or near the work covered by the contract.

When separate contracts are let within the limits of one project, each contractor shall conduct his work so as not to hinder the progress of the work being performed by other contractors. Contractors working on the same project shall cooperate with each other as directed.

Each contractor shall assume all liability, financial or otherwise, in connection with his contract and shall indemnify the Department from all damages or claims that may arise because of inconvenience, delay or loss experienced by him because of the presence and operations of other contractors working within the limits of the same project.

The contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of the other contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.08 CONSTRUCTION STAKES, LINES AND GRADES. The

engineer will set construction stakes establishing lines, slopes, and continuous profile grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he deems necessary, and will furnish the contractor with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work.

The contractor shall be responsible for the preservation of all stakes and marks established by the engineer and, if any construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing same will be charged to the contractor and will be deducted from the payments for the work.

The Department shall be responsible for the accuracy of all lines, measurements, stakes, elevations and grades or other engineering layout and control work done by its authorized representatives, unless otherwise stipulated in the project specifications.

105.09 AUTHORITY AND DUTIES OF PROJECT ENGINEER. As the direct representative of the engineer, the project engineer has immediate charge of the Department's engineering details of each construction project. He is responsible to the Department for the administration and satisfactory completion of the contract. The project engineer shall have the authority to reject defective material and to suspend any work that is being improperly performed. In no case will he perform any duties for or act as the representative of the contractor.

105.10 DUTIES OF THE INSPECTOR. Inspectors employed by the Department will be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications or to act as foreman for the contractor; however, he shall have the authority to reject work or materials until any question at issue can be referred to and decided by the engineer.

105.11 INSPECTION OF WORK. All materials and each part or detail of the work shall be subject to inspection by the engineer. The engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection.

If the engineer requests it, the contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as directed. After examination, the contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the

tractor shall maintain the work during construction and until the project is accepted. This maintenance shall constitute continuous and effective work prosecuted daily with adequate equipment and forces to keep the roadway or structures in satisfactory condition at all times.

In the case of a contract for the placing of a course on a previously constructed course or subgrade, the contractor shall maintain the previous course or subgrade during all construction operations.

Except as provided elsewhere in these specifications, all cost of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the contractor will not be paid an additional amount for such work.

105.16 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE. If at any time, the contractor fails to comply with the provisions of Subsection 105.15 the engineer will immediately notify the contractor, in writing, of such non-compliance. If the contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from payments due or to become due the contractor.

If the unsatisfactory maintenance results in a condition that is hazardous to life, health and property of the public, or to the integrity of the work, the engineer may declare an emergency situation and may immediately proceed to effect the repairs necessary, and will charge the entire cost to the contractor.

105.17 ACCEPTANCE.

(a) Partial Acceptance: If at any time during the prosecution of the project, the contractor satisfactorily completes a portion of the project, such as a structure, an interchange or a section of road or pavement that can be used advantageously for traffic, he may request the engineer to make final inspection of that portion. If the engineer finds upon inspection that the portion has been satisfactorily completed in compliance with the contract he may accept that portion as being completed and the contractor will be relieved of further responsibility for that portion and from further liability to the public.

In no event will partial acceptance of a project be made until that portion being accepted has been completed in its entirety, including all safety devices, signs and striping. If partial acceptance is made, the terms of the acceptance, including the responsibilities of all parties and any allowance of additional contract time, shall be set forth in a change order, mutually agreed to by the engineer and the contractor, with the concurrence of any unit of government or political subdivision or any corporation having monetary interest in the work. Such partial acceptance shall in no way void

or alter any terms of the contract, except as set forth in the change order.

(b) Final Acceptance: Upon due notice from the contractor of presumptive completion of the entire project, the engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the engineer will make the final acceptance and notify the contractor in writing of this acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the engineer will give the contractor the necessary instructions for correction of same, and the contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the engineer will make the final acceptance and notify the contractor in writing of this acceptance as of the date of final inspection.

105.18 CLAIMS FOR ADJUSTMENT AND DISPUTES. If the contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the engineer as extra work, as defined herein, the contractor shall notify the engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given and the engineer is not afforded proper facilities by the contractor for keeping strict account of actual cost as required, the contractor hereby agrees to waive any claim for such additional compensation. Such notice by the contractor and the fact that the engineer has kept account of the cost as aforesaid shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the engineer, is found to be just, it will be paid for as extra work or as provided herein for force account work. Nothing in this Subsection shall be construed as establishing any claim contrary to the terms of Subsection 104.02.

Section 106

Control of Materials

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS. The materials used on the work shall meet all quality requirements of the contract. In order to expedite the inspection and testing of materials, the contractor shall notify the engineer of his proposed sources of materials prior to delivery. At the option of the engineer, materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the contractor shall furnish materials from other sources or make necessary changes to provide acceptable materials.

106.02 LOCAL MATERIAL SOURCES.

(a) **Designated Sources:** Possible sources of local materials may be designated on the plans and described in the project specifications. The quality of material in such deposits will be acceptable in general, but the contractor shall determine for himself the amount of equipment and work required to produce a material meeting the specifications. It shall be understood that it is not feasible to ascertain from samples the limits for an entire deposit and that variations shall be considered as usual and are to be expected. The engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable prior to incorporation in the work.

The Department may acquire and make available to the contractor the right to take materials from the sources designated on the plans and described in the project specifications, together with the right to use such property as may be specified, for plant site, stockpiles and hauling roads.

(b) **Contractor Furnished Sources:** If the contractor desires to use material from sources other than those designated, he shall acquire the necessary rights and/or permits to take materials from the sources and shall pay all costs related thereto, including any which may result from an increase in length of haul. All costs of exploring and developing such other sources shall be borne by the contractor. The use of material from other than designated sources will not be permitted until representative samples taken by the engineer have been approved and written authority is issued for the use thereof.

When material deposits are not designated in the project specifications, the contractor shall provide sources of material acceptable to the engineer.

When sources of material or material deposits are provided by the contractor, the Department may assume the cost of processing samples to determine the suitability of the material.

Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition.

Unless otherwise authorized by the engineer in writing, borrow pits, gravel pits and quarry sites shall be located not less than 300 feet from the highway right-of-way.

When sources of material or material deposits are located adjacent to a stream or river listed on the National System of Wild and Scenic Rivers or the Louisiana Natural and Scenic Rivers System, the borrow pits, gravel pits, quarry sites and any stockpiled materials shall be located not less than 300 feet from the natural bank of the stream.

106.03 SAMPLES, TESTS, CITED SPECIFICATIONS. All materials will be inspected, tested and approved by the engineer before incorporation in the work. Any work in which untested and unapproved materials are used, without approval of the engineer, shall be performed at the contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the engineer, shall be removed at the contractor's expense. Unless otherwise designated, samples and tests will be run in accordance with the cited standard method of the Department's Materials Sampling Manual and the Testing Procedures Manual; if not contained therein, by the AASHTO methods. If a procedure is not available in AASHTO, then the ASTM procedure will be used, except for any resampling or retesting procedures included therein. Resampling or retesting procedures shall be as determined by the Department's Material Engineer. Sampling and testing procedures not contained as above shall be as determined by the engineer. All procedures will be the most recent cited which are current on the date of the advertisement for bids. Unless otherwise designated, all testing will be made by and at the expense of the Department. Samples will be taken by a qualified representative of the Department. All materials being used are subject to inspection, test or rejection at any time prior to or during incorporation into the work. Copies of all test reports will be furnished to the contractor's representative at his request.

106.04 CERTIFICATES OF COMPLIANCE. A Certificate of Compliance shall be furnished prior to the use of any materials for which the specifications require that such a certificate be furnished. The certificate shall be signed by the manufacturer of the material, the manufacturer of assembled materials or the supplier of the material and shall state that the materials involved comply in all respects with the requirements of the specifications. A

Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the contractor of responsibility for incorporating material in the work which conforms to the requirements of the plans and specifications. Any such material not conforming to such requirements will be subject to rejection.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

Distribution of Certificates of Compliance and requirements for further sampling and testing of certified materials shall be as outlined in the Department's Materials Sampling Manual.

106.05 PLANT INSPECTION. The engineer may undertake the inspection of materials at the source.

If plant inspection is undertaken, the following conditions shall be met:

(a) The engineer shall have the cooperation and assistance of the contractor and the producer with whom he has contracted for materials.

(b) The engineer shall have entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.

(c) If required by the engineer, the contractor shall arrange for an approved building for the use of the inspector, such building to be located conveniently near the plant, independent of any building used by the material producer and conforming to Subsection 106.06.

(d) Adequate safety measures are to be provided and maintained.

The Department reserves the right to retest all materials, prior to incorporation into the work, which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of the project specifications.

106.06 FIELD LABORATORY. The contractor shall provide one or more suitable shelters or field laboratories as required in accordance with Section 722 to house and use the equipment essential to the Department's inspectors to carry on the required tests.

106.07 FOREIGN MATERIALS. Materials manufactured outside the United States shall be delivered to approved locations within the State unless otherwise permitted by the contract, where they shall be retained until sampling and testing can be completed.

The contractor shall, at no cost to the Department, arrange for any required

testing which the Department is not equipped to perform. All testing by the contractor shall be performed within the State and be subject to witnessing by the engineer.

Each lot of foreign material shall be accompanied by a Certificate of Compliance prepared in accordance with Subsection 106.04. In addition, certified certificates of analysis shall be attached to the Certificate of Compliance for those materials for which certificates of analysis are required and shall clearly identify the lot to which they apply.

Structural materials requiring mill test reports will be accepted only from those foreign manufacturers who have previously established to the satisfaction of the engineer the adequacy of their in-plant quality control to assure delivery of uniform material in conformance with contract requirements.

Adequacy of quality control shall be established at the option of the engineer, by submission of detailed written proof of adequate control, or through an in-plant inspection by the engineer or his representative.

No structural materials will be accepted which cannot be properly identified with mill test reports and Certificates of Compliance.

106.08 STORAGE OF MATERIALS. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right-of-way may be used for storage purposes and for the placing of the contractor's plant and equipment, but any additional space required therefor must be provided by the contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner and lessee and, if requested by the engineer, copies of such written permission shall be furnished him. All storage sites shall be restored to their original condition or to the satisfaction of the owner or lessee by the contractor at his expense. This shall not apply to the stripping and storing of topsoil or to other material salvaged from the work.

106.09 HANDLING MATERIALS. All materials shall be handled in such manner as to preserve their quality and fitness for the work. The materials shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded and the quantities as actually received at the place of operations.

106.10 UNACCEPTABLE MATERIALS. All materials not conforming to the requirements of the specifications shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed by the engi-

neer. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

106.11 DEPARTMENT-FURNISHED MATERIAL. The contractor shall furnish all materials required to complete the work except those specified to be furnished by the Department.

Material furnished by the Department will be delivered or made available to the contractor at the points specified in the project specifications.

The cost of handling and placing all materials after they are delivered to the contractor shall be considered as included in the contract price for the item in connection with which they are used.

The contractor will be held responsible for all material delivered to him and deductions will be made from any payments due him to make good any shortages and deficiencies from any cause and for any damage which occurs after such delivery, and for any demurrage charges.

Section 107

Legal Relations and Responsibility to Public

107.01 LAWS TO BE OBSERVED.

General: The contractor shall keep fully informed of all Federal, State and local laws, ordinances and regulations, and all orders and decrees of bodies of tribunals having any jurisdiction or authority, which affect those engaged or employed on the work or which affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, codes, regulations, orders and decrees; and shall indemnify the state and its representatives against any claim or liability arising from the violation of any such law, bylaw, ordinance, code, regulation, order or decree, whether by himself or his employees.

Soil and any soil-moving equipment operating in regulated areas will be subject to plant quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from regulated areas to prevent the spread of harmful agricultural pests from areas quarantined by the State or U. S. Department of Agriculture. Complete information may be secured by contacting the appropriate district office of the USDA Plant Protection Division.

107.02 PERMITS, LICENSES AND TAXES. Except as otherwise provided, the contractor shall procure all permits and licenses, pay all charges, fees, and taxes and give all notices necessary to the due and lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIALS AND PROCESSES. If the contractor employs any design, device, material or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The contractor and the surety shall indemnify the State, any affected third party or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright and shall indemnify the state for any costs, expenses and damages which it may be obliged to pay by reason of any infringement at any time during the prosecution or after completion of the work.

107.04 RESTORATION OF SURFACES OPENED BY PERMIT. The right to construct or reconstruct any utility service in the highway or

street or to grant permits for same, at any time, is expressly reserved by the Department for the proper authorities of the municipality in which the work is done and the contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

When an individual, firm, or corporation is authorized through a duly executed permit from the Department, the contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. The contractor shall, when ordered by the engineer, make in an acceptable manner all necessary repairs due to such openings and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 FEDERAL AID PARTICIPATION. When the United States Government participates in the cost of the work covered by the contract, the work shall be under the supervision of the State but subject to the inspection and approval of the proper officials of the United States Government and in accordance with the applicable Federal Statutes and rules and regulations made pursuant thereto. Such inspection shall in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party thereunder.

On all Federal Aid projects the contractor will be required to complete Federal Aid Form PR-47, entitled, "Statement of Materials and Labor used by Contractors on Highway Construction Involving Federal Funds," prior to the time final inspection is requested for the project. In no case will the final estimate be paid until this form has been submitted to the Federal Highway Administration and accepted by them.

107.06 SANITARY, HEALTH, AND SAFETY PROVISIONS. The contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and local Boards of Health or of other bodies or tribunals having jurisdiction.

Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The contractor shall not require any worker to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his health or safety.

The disposition of sewage shall be as approved by the appropriate health agency.

107.07 PUBLIC CONVENIENCE AND SAFETY. The contractor shall at all times so conduct his work as to assure the least possible obstruction to traffic.

When the road under construction is to be kept open for the use of the traveling public, the subgrade and surfacing shall be kept reasonably free from dust and in such condition that the public can travel the road in safety.

The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be a primary responsibility of the contractor.

If the contractor elects to work at night, adequate artificial lighting, signs, flagmen or other traffic controls shall be provided to protect the workmen, the work and the traveling public. When such work affects traffic safety, the contractor shall submit to the engineer for his approval a plan of lighting, signing, flagmen or other traffic controls. If the approved plan proves inadequate after work begins, the contractor shall make such changes as the engineer requires. If the engineer finds that the night work is so hazardous as to preclude the beginning or require the discontinuing of such work, the contractor shall immediately cease all such operations. All costs of providing or making changes in the lighting, signs, flagmen or other traffic controls shall be the responsibility of the contractor.

107.08 RAILWAY-HIGHWAY PROVISIONS. All work to be performed by the contractor in construction on railway right-of-way shall be in accordance with the following provisions:

(a) The contractor shall notify the Railway's duly designated representative at least 10 days in advance of the date on which contractor expects to begin any work on or about the Railway's tracks or premises.

(b) During the entire progress of work on or about the Railway's tracks or premises, the contractor shall maintain contact and liaison with such of the Railway's officers or representatives as shall be designated by the Railway so as to ascertain time of passage of trains at the site of the project and so as to clear Railway's tracks and facilities of men, equipment and obstructions to permit free flow of railway traffic. The contractor shall perform all work on or about the Railway's tracks and premises without materially interfering with the Railway's tracks, structures and facilities, operations, or the operations of the Railway's tenants or licensees, or with communication and signal lines upon said premises, except under arrangements effected between the contractor and the Railway. The contractor shall use the utmost care in protecting the Railway's property and in avoiding accidents. The contractor shall at all times keep the Railway's track and roadbed free of earth, rock, construction materials, debris and obstructions in any manner deposited during the progress of the work.

(c) The contractor shall, before entering upon the Railway's right-of-way for performance of any construction work, or work preparatory thereto, secure permission from the Railway's representative for the occupancy and use of the Railway's right-of-way outside the limits of the highway servitude area and shall confer with the Railway relative to requirements for railway clearances, operation and general safety regulations.

(d) The Railway's representative will at all times have jurisdiction over the safety of railway operation, and the decision of the Railway's repre-

sentative as to procedures which may affect the safety of railway operation shall be final and the contractor must be governed by such decision.

(e) Should any damage occur to railway property, as a result of the contractor's unauthorized or negligent operations, and the Railway deems it necessary to repair such damage or perform any work for the protection of its property, the required materials, labor and equipment shall be furnished by the Railway, and the contractor shall reimburse the Railway for costs incurred.

(f) If the contractor desires access across the Railway's right-of-way and tracks at any location not being an existing permanent type of open public railway-highway road crossing in or incident to the construction of the project, the Railway shall cooperate with the contractor and permit the contractor access across said right-of-way and tracks provided the contractor first executes a license agreement with the Railway and agrees to reimburse the Railway for the cost of providing and removing any temporary grade crossing, including warning devices, watchmen expense or other costs which the Railway deems necessary for protection of Railway property and operations. The type of temporary crossing required shall be determined by the Railway. The contractor shall at no time cross the Railway's right-of-way and tracks with vehicles or equipment of any kind or character except at existing and open public road crossings or except at such crossing or crossings as may be established pursuant to this paragraph. The foregoing requirements are meant to include new grade crossing or crossings which will become part of the finished highway being constructed under the contract.

The contractor shall comply with requirements for insurance contained under Heading (n) hereinafter during operations hereunder.

The contractor shall cooperate fully with the Railway during all phases of the work including sufficient advance notice for project completion in order for the Railway to remove the temporary grade crossing and perform final grade crossing improvements under its agreement with the Department prior to final acceptance of the highway project.

(g) Any engineering, inspection, flagging protection and/or watchmen service required by the Railway for the safety of Railway operations because of work being performed by the contractor or in connection therewith, shall be provided by the Railway and the cost thereof shall be reimbursed to the Railway on the basis of the Railway's bills, to be rendered monthly. The contractor must include in his unit prices bid, sufficient money to cover the cost of such protection.

Wage rates quoted to or used by the contractor in preparing his bid are subject to change at any time by law or by agreement between the Railway and its employees, and may be retroactive as a result of negotiations or a ruling of an authorized Governmental Agency. Additional charges on labor are

also subject to change. If the wage rates or additional charges are changed, the contractor shall pay on the basis of the new rates and new charges.

In order that the Railway may be prepared to furnish protective services, the contractor shall notify the Railway 72 hours in advance of when the protection services are required.

(h) The contractor will be required to reimburse monthly the Railway for the costs of all services performed by the Railway for the contractor, and furnish the Department satisfactory evidence that the Railway has acknowledged receipt of same before final settlement.

(i) During the construction of piers or other supports or structures adjacent to any track or of drainage pipe or structure under or adjacent to any track of the Railway, the contractor shall make adequate provisions against sliding, shifting, sinking, or in any way disturbing the railway embankment and track adjacent to said piers, supports or structures due to his construction operations, by driving temporary sheeting in a manner satisfactory to the Department's and Railway's representatives.

(j) Before commencing work on any pier or structure adjacent to any track, or on any structure and parts thereof which carry Railway facilities, the contractor shall submit to the engineer for approval, prints of the proposed sheeting, shoring, bracing and falsework details for protection of the Railway's track and embankment and shall submit prints of the shop drawings or other contractor's detailed plans for structures and parts thereof which will carry Railway facilities. This submittal to the engineer shall include proposed methods of construction and be accompanied by supporting data, including design computations, soil descriptions and other pertinent information.

After approval by the engineer, 4 prints of the above plans, shop drawings and details bearing the seal of a registered professional structural engineer, together with supporting data and documents, shall be forwarded to the Railway for review and approval.

(k) The contractor shall notify the Railway's representative (in writing) not less than one week in advance of the proposed time of the beginning of the construction of piers, supports or structures adjacent to the track or of drainage pipe or structure under or adjacent to the track.

(l) The following temporary clearances are the minimum which must be maintained at all times during the construction operations:

Vertical:	22′—6″ above top of highest rail
Horizontal:	10′—0″ from center line of the nearest track measured at right angles thereto.

If lesser clearances than the above are required for any part of the work, the contractor shall secure written authorization from the Railway's represent-

ative for such lesser clearances in advance of the start of work on that portion of the project along, on, over, under or across the right-of-way or tracks of the Railway or construct any falsework.

(m) The contractor shall not store any materials, supplies or equipment closer than 15′—0″ from the centerline of any railway track, measured at right angles thereto, or 22′—6″ vertically from top of rail.

(n) The contractor shall provide, in addition to any other form of insurance or bond required, insurance of the following kinds and amounts:

(1) Regular Contractors' Public Liability and Property Damage Insurance including automobile issued in the names of the Contractors shall be so written as to furnish protection to contractors respecting their operations in performing work covered by their contract in regard to their liability with respect to bodily injury to or death of persons, and injury to or destruction of property, which may be suffered by persons other than their own employees as a result of their operations in connection with construction of highway projects located wholly or partly within railroad right-of-way.

(2) Where a contractor sublets a part of the work on any project to a subcontractor, the contractor shall be required to secure insurance protection in his own behalf under Contractor's Public Liability and Property Damage Insurance policies to cover any liability imposed on him by law for damages because of bodily injury to or death of persons and injury to or destruction of property as a result of work undertaken by such subcontractors. In addition, the contractor shall provide for and on behalf of any such subcontractors protection to cover like liability imposed upon the latter as a result of their operations by means of separate and individual Contractor's Public Liability and Property Damage policies; or, in the alternative, each subcontractor shall provide satisfactory insurance on his own behalf to cover his individual operations.

(3) Railroad Protective Liability Insurance shall be purchased on behalf of the Railway by the Contractor. The standards for Railroad Protective Liability Insurance shall be in accordance with provisions of Volume 6, Chapter 6, Section 2, Subsection 2 of the Federal-Aid Highway Program Manual, as amended.

The limits of liability for the kinds of insurance required above shall be as follows:

	(1) and (2)	(3)
Bodily injury-each person	$ 500,000.00	$ 500,000.00
Bodily injury-each occurence	$1,000,000.00	$1,000,000.00

Property damage-each occurence	$ 500,000.00	$ 500,000.00
Property damage-aggregate limit	$1,000,000.00	$1,000,000.00

The contractor shall furnish to the Railway the Railroad Protective Policy and certificates evidencing the other insurance coverage required above. The Railroad Protective policy and all insurance certificates shall be subject to the Railway's approval before any work may be started on the Railway's property by the contractor or his subcontractors. In addition, the contractor shall furnish an evidence of commitment by the insurance company to notify the Railway and the Department in writing of any material change, expiration or cancellation of the policy not less than 30 days before such change, expiration or cancellation is effective.

The insurance specified shall be kept in force until all work required to be performed has been satisfactorily completed and accepted in accordance with the contract under which the construction work is undertaken.

(o) Upon completion of the work, the contractor shall within 10 days remove from within the limits of Railway's right-of-way, all machinery, equipment, surplus materials, falsework, rubbish or temporary buildings of said contractor, and restore the Railway's premises substantially to their former condition and satisfactory to the Railway's representative.

Should the contractor fail to make such removal and restoration within 10 days, if deemed necessary by the Railway's representative, the Railway shall have the right to make such removal or restoration and the expense so incurred shall be chargeable to the project on the Railway's force account statement.

All work or operations performed by the contractor for or on account of the Railway during highway construction operations under the contract, or by the Railway in constructing and maintaining the temporary or other grade crossing for the contractor's use during highway construction, or by the Railway in furnishing flagmen or other protection in accordance with agreement between the contractor and the Railway, or for cleaning up and restoring the Railway's premises as required above, or for work as contained in the contract shall be considered incidental to the contract and all costs for same shall be included in contract prices on pay items.

Prior to final acceptance of the project the contractor shall secure a certificate of release from the railway company and furnish same to the Department stating that the contractor has satisfactorily restored the railway's premises and has completed payments for all railway services performed for the contractor's account, and that the railway waives all claims for damages due to the contractor's operations within railway right-of-way under this contract.

107.09 CONSTRUCTION IN, OVER OR ADJACENT TO NAVIGABLE WATERS AND WETLANDS.

All work in, over, adjacent or contiguous to navigable waters and/or wetlands shall be conducted in accordance with the rules and regulations of the U. S. Army, Corps of Engineers and the U. S. Coast Guard.

Navigable clearances on waterways shall not be infringed upon, and existing navigable depths shall not be impaired except as allowed by permits issued by the responsible agency.

The Department will obtain a permit from the Department of Transportation, U. S. Coast Guard, and the Department of the Army, Corps of Engineers relative to approval of construction plans for bridges, causeways, embankments, dredging and spoil disposal, etc., for work in navigable waters and/or wetlands. The contractor will be furnished a copy of the permit. The contractor shall be responsible for conformance with all provisions and conditions of the permit.

The contractor shall prepare reproducible drawings complying with the standards of the U. S. Coast Guard and the Corps of Engineers showing falsework construction, test pile, or other temporary pile driving operations, erection sequence, temporary navigational lighting, location of equipment and barges in the navigable limits and any other drawings required by the permit agencies. Drawing sizes shall be 8''x10½'' with a 1'' border on the top or short side. The drawings shall be submitted to the Bridge Design Engineer for approval and transmittal to the appropriate agency.

Construction of falsework, test pile operations, erection or operation of any construction equipment within the navigable limits shall not be commenced until the drawings are approved.

The contractor will be required to display lights on his equipment operating, berthed or moored in navigable streams, and to provide temporary navigational lighting on all temporary and permanent construction in the navigable limits as required by the U. S. Coast Guard.

Should the contractor, during the course of the work, sink, lose or throw overboard any material, plant machinery or equipment which may be dangerous to navigation, he shall immediately remove or recover such obstruction. The contractor shall give immediate notice of such obstruction to the proper authorities and, if required, shall mark or buoy such obstruction until it is removed.

Under no circumstances shall the contractor deposit excavated material into the waterway or wetland without a permit from the appropriate agency.

All operations in connection with the work shall be in accordance with the permits and rules and regulations of the Department of the Army, Corps of Engineers and the U. S. Department of Transportation, U. S. Coast Guard, and any deviations therefrom shall be only by special permissions or special

permits which are the responsibility of the contractor. Failure of the contractor to familiarize himself with all of the terms, conditions, and provisions of the permits and the rules and regulations applicable to the work shall not relieve the contractor of his responsibility under the contract.

The contractor shall conduct his operations in such manner as to cause minimum interference with marine operations. If such interference is necessary, the contractor shall notify the Bridge Design Engineer, in writing, sufficiently in advance so that the Department may obtain approval from the U. S. Coast Guard at least three weeks prior to said interference.

Copies of any special permits obtained by the contractor must be submitted immediately to the Bridge Design Engineer.

107.10 BARRICADES AND WARNING SIGNS. The contractor shall provide, erect and maintain all necessary barricades, suitable lights, danger signals, signs and other traffic control devices and shall take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades and obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to control and to direct traffic.

The contractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be placed and maintained in accordance with the plans.

All barricades, warnings signs, lights, temporary signals and other protective devices must conform with the Louisiana MUTCD, except that battery operated flashing warning lights conforming to Subsection 1017.12 will be permitted at locations approved by the engineer.

Unless a pay item for "Temporary Signs and Barricades" is provided in the contract, all materials furnished and work performed as provided by this Subsection shall be considered as subsidiary and the costs thereof shall be included in the various bid items of the contract.

107.11 USE OF EXPLOSIVES. When the use of explosives is deemed necessary for the prosecution of the work, and when approved, the contractor shall exercise the utmost care not to endanger life or property, including new work. Their use shall be in strict compliance with all laws and ordinances. The contractor shall be responsible for any and all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner, in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the engineer not closer than 1,000 feet from any road, building, camping area or place of human occupancy.

The contractor shall notify in writing each public utility company having facilities in proximity to the site of the work of his intention to use explosives and such notice shall be given sufficiently in advance to enable them to take such steps as they deem necessary to protect their property from damage.

107.12 PRESERVATION AND RESTORATION OF PROPERTY, LANDSCAPE, AND SURVEY MONUMENTS. The contractor shall be responsible for the preservation of all public and private property and shall protect from disturbance and damage all land monuments, property line markers or horizontal and vertical control monuments such as those established by the United States Coast and Geodetic Survey, Louisiana Geodetic Survey, Corps of Engineers, or United States Geological Survey.

Before removing and resetting any such survey monuments, the contractor shall give sufficient advance notice in writing to the appropriate agency responsible for the monument and to the engineer of his intention to perform the work in order that such agency may have a representative present if it so desires. Under no conditions shall the contractor disturb or move any such monument without the approval of the engineer.

The engineer will designate the location and manner in which these monuments are to be reset.

The contractor shall be responsible for all damage to property during the prosecution of the work resulting from any negligent act, omission or misconduct in his executing the work, or at any time due to defective work or materials, and said responsibility will not end until the project has been completed and accepted.

If any damage is done to public or private property by or on account of any negligent act, omission or misconduct in the execution of the work, or in consequence of the nonexecution thereof by the contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage was done by repairing, rebuilding or otherwise restoring as directed, or he shall make good such damage in an acceptable manner.

107.13 FOREST PROTECTION. In carrying out work within or adjacent to State or National Forests, the contractor shall comply with all regulations of the State Fire Marshal, Conservation Commission, Forestry Department or other authority having jurisdiction governing the protection of forests and the carrying out of work within forests, and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the requirements of the forest supervisor.

The contractor shall take all reasonable precaution to prevent and suppress forest fires and shall require his employees and subcontractors, both independently and at the request of forest officials, to do all reasonably within

their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a forest official at the earliest possible moment of the location and extent of any fire seen by them.

107.14 PREVENTION OF SOIL EROSION AND WATER POLLUTION. The contractor shall exercise planning and forethought in coordinating the work of protecting the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods of either a temporary or permanent nature. The area of bare soil exposed at any one time by construction operations shall be kept to a minimum.

Special attention is directed to Subsections 107.15, 204.02, 204.05, 204.06, 204.07 and 204.09, which will be applied to all work regardless of whether pay items are provided in the contract or not.

107.15 ENVIRONMENTAL PROTECTION. The contractor shall comply with all Federal, State and local laws and regulations controlling pollution of the environment, including air, water and noise. He shall take necessary precautions to prevent pollution of all waters and wetlands with fuels, oils, asphalts, chemicals or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

Attention is directed to Subsection 107.14 and Section 204 concerning temporary erosion control.

Attention is further directed to the Louisiana Air Control Commission and local air pollution control programs within the State and their rules and regulations regarding air pollution matters, especially open burning, fugitive dust and asphaltic concrete plant restrictions.

107.16 RESPONSIBILITY FOR DAMAGE CLAIMS. The contractor shall indemnify the Department, its officers and employees from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person or property on account of the operations of the said contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any negligent act, omission or misconduct of said contractor; or because of any claims or amounts recovered from any infringements of patent, trademark or copyright; or from any claims for amount arising or recovered under the Workmen's Compensation Act or any other law, ordinance, order or decree; and so much of the money due the said contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of the State; or, in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid have been settled and suitable evidence to that effect furnished to the Department; except that money due the contractor will not be withheld when the contractor produces satisfactory evidence that he is adequately protected by

public liability and property damage insurance, including railroad protective liability insurance in accordance with Subsection 107.08.

107.17 OPENING SECTIONS OF PROJECT TO TRAFFIC. Opening of sections of the work to traffic prior to completion of the entire contract may be desirable from a traffic service standpoint or may be necessary due to conditions inherent in the work or by changes in the contractor's work schedule and may be required due to conditions or events unforeseen at the time of the contract. Such openings as may be necessary due to any of the foregoing conditions shall be made when so ordered by the engineer. Under no condition shall such openings constitute acceptance of the work or a part thereof or a waiver of any provisions of the contract.

The plans or project specifications will specify, insofar as possible, which sections shall be opened prior to completion of the contract. On any section opened by order of the engineer, whether specified in the contract or not, the contractor will not be required to assume any expense entailed in maintaining the road for traffic. Such expense shall be borne by the Department or compensated for in a manner provided in Subsection 109.04. On such portions of the project which are ordered by the engineer to be opened for traffic, in the case of unforeseen necessity which is not the fault of the contractor, any compensation for additional expense to the contractor and any allowance of additional time for completion of other items of work on such opened portions of the project shall be as set forth in a change order mutually agreed on by the engineer and the contractor as set forth hereinafter.

If the contractor is dilatory in completing shoulders, drainage structures or other features of the work the engineer may so notify him in writing and establish therein a reasonable period of time in which the work should be completed. If the contractor is dilatory or fails to make a reasonable effort toward completion in this period of time, the engineer may order all or a portion of the project opened to traffic. On such sections ordered to be opened, the contractor shall conduct the remainder of his construction operations so as to cause the least obstruction to traffic and shall not receive any added compensation due to the added cost of the work by reason of opening such section to traffic.

On any section opened to traffic under any of the above conditions, whether specified in the contract or opened by necessity of contractor's operations or unforeseen necessity, any damage to the highway not attributable to traffic which occurs on such section (except slides) shall be repaired by the contractor at his expense. Removal of slides shall be done by the contractor on a basis agreed to prior to removal of such slides.

107.18 CONTRACTOR'S RESONSIBILITY FOR WORK. Until final written acceptance of the project by the engineer, the contractor shall have the charge and care thereof and shall take every precaution against damage to any part thereof by the action of the elements or from any other

cause, whether arising from the execution or nonexecution of the work. The contractor shall rebuild, repair, restore and make good all damages to any portion of the work before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the contractor, including but not restricted to acts of God, of the public enemy or of governmental authorities.

In case of suspension of work from any cause, the contractor shall be responsible for the project and shall take such precautions as necessary to prevent damage to the project, provide for normal drainage and erect any necessary temporary structures, signs or other facilities at his expense. During such period of suspension of work, the contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings and soddings furnished under his contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against damage.

107.19 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES. At points where the contractor's operations are adjacent to properties of railway, telegraph, telephone and power companies or are adjacent to other property, damage to which might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and that duplication of rearrangement work may be reduced to a minimum and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption to utility services as a result of accidental breakage or as a result of being exposed or unsupported, the contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of service. If utility service is interrupted continuous cooperation will be required until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

107.20 FURNISHING RIGHT-OF-WAY. The Department will be responsible for the securing of all necessary rights-of-way, servitudes and/or easements in advance of construction. Any exceptions will be indicated in the contract.

107.21 PERSONAL LIABILITY OF PUBLIC OFFICIALS. In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Assistant Secretary, Chief Engineer or their authorized representatives, either personally or as officials of the State,

it being understood that in all such matters they act solely as agents and representatives of the State.

107.22 NO WAIVER OF LEGAL RIGHTS. Upon completion of the work, the Department will expeditiously make final inspection and notify the contractor of acceptance. Such final acceptance shall not prevent the Department from correcting any measurement, estimate or certificate made before or after completion of the work, nor shall the Department be prevented from recovering from the contractor or his surety, or both, such overpayment as it may sustain, or by failure on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107.23 THIRD PARTY LIABILITY. It is agreed between the parties executing this contract that it is not intended by any provisions of the contract to create the public nor any member thereof a third party beneficiary hereunder, nor to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this contract.

Section 108

Prosecution and Progress

108.01 SUBLETTING OF CONTRACT. The contractor shall not sublet, sell, transfer, assign or otherwise dispose of the contract or any portion thereof, or of his right, title or interest therein, without written consent of the engineer. If such consent is given, the contractor will be permitted to sublet a portion of the work but shall perform with his own organization work amounting to not less than 50 percent of the total contract cost. Any items designated in the contract as "Specialty Items" may be performed by subcontract and the cost of any such Specialty Items so performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the contractor with his own organization. No subcontracts or transfer of contract shall serve to relieve the contractor of his liability under the contract and bonds.

An approved subcontractor shall not subcontract any portion of his authorized work.

108.02 NOTICE TO PROCEED. The "Notice to Proceed" will stipulate the date on which the contractor shall begin the construction, which date shall be the beginning of the contract time charges.

108.03 CONSTRUCTION PROGRESS SCHEDULE. Prior to award of the contract, the contractor shall submit to the Department a Construction Progress Schedule giving a satisfactory schedule of operations that will provide for completion of the work within the contract time limit. This schedule shall be on a prescribed bar type graph form and submitted to the Construction Section for approval. When the Notice to Proceed is issued, a copy of the approved schedule will be returned to the contractor.

If the contractor's operations are materially affected by changes in the plans or in the amount of work, or if he has failed to comply with the approved schedule, the contractor shall submit a revised Construction Progress Schedule. If requested by the engineer, this schedule shall show how he proposes to prosecute the balance of the work. In this case the contractor shall submit the revised schedule within 10 days after the date of the request. In any case, the schedule may be revised upon request of either party, but before a revision requested by the contractor will apply, it must be approved by the engineer.

The approved Construction Progress Schedule will be used as the basis of establishing the controlling items of work, assessing contract time and as a check on the progress of the work.

108.04 PROSECUTION OF WORK.

(a) General: The contractor shall provide sufficient materials, equipment and labor to guarantee completion of the project in accordance with the plans and specifications within the contract time limit. If the completed work on any contract is behind the approved progress schedule, the contractor shall take immediate steps to restore satisfactory progress. Each item of construction shall be prosecuted to completion without delay and in no instance shall the contractor transfer his equipment or forces from uncompleted construction without prior notice to, and approval of, the engineer. If the prosecution of the work is discontinued for an extended period of time, the contractor shall give the Project Engineer written notice at least 24 hours before resuming operations.

(b) Disqualification: The contractor's progress will be determined monthly at the time of each partial estimate, and will be based on the total amount earned by the contractor as reflected by the partial estimate. If the contractor's progress is more than 20% behind the elapsed contract time, he will be notified that he will be subject to disqualification if his progress becomes delinquent by more than the percentages specified hereinafter, and such additional notification will be made as the engineer deems necessary concerning the progress delinquency of the contractor.

Prior to the elapsing of 55% of the contract time, the contractor will be disqualified if his progress on any contract is more than 40% behind the elapsed contract time. After 70% of the contract time has elapsed, the contractor will be disqualified if his progress on any contract is more than 25% behind the elapsed contract time. Disqualification will be applied between 55% and 70% contract time elapsed on a pro-rata basis; for example, when 60% of the contract time has elapsed, the contractor will be disqualified if his progress on any contract is more than 35% behind the elapsed contract time.

During the period of disqualification, the contractor will not be permitted to bid on future contracts nor will he be approved as a subcontractor on future contracts. The period of disqualification will continue until the completed work on the contract is not delinquent by more than the foregoing percentages or until all work on the contract has been satisfactorily completed.

108.05 LIMITATION OF OPERATIONS. The contractor shall conduct the work at all times in such manner and sequence as will assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started, and the engineer may require

the contractor to finish a section on which work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

108.06 CHARACTER OF WORKMEN; METHODS AND EQUIPMENT. The contractor shall at all times employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by these specifications.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the contractor or by any subcontractor who, in the opinion of the engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the engineer, be removed forthwith by the contractor or subcontractor employing such person and shall not again be employed in any portion of the work without the approval of the engineer. Should the contractor fail to remove such a person or fail to furnish suitable and sufficient personnel for proper prosecution of the work, the engineer may suspend the work by written notice until such orders are complied with.

All equipment proposed for use on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no damage to the roadway, adjacent property or other highways will result from its use.

When the methods and equipment to be used by the contractor in accomplishing the construction are not prescribed in the contract, the contractor is free to use any methods or equipment that will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the engineer. If the contractor desires to use a method or type of equipment other than specified in the contract, he may request authority from the engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and the reasons for desiring to make the change. If approval is given, it will be on the condition that the contractor will be responsible for producing construction work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the engineer determines that the work produced does not meet contract requirements, the contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The contractor shall remove the deficient work and replace it with work of specified quality or take such other corrective action

as the engineer directs. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.07 DETERMINATION AND EXTENSION OF CONTRACT TIME. The number of days allowed for completion of the work included in the contract will be stated in the proposal and contract, and will be known as the "Contract Time."

When the contract time is on a working day basis, the engineer will furnish the contractor a monthly statement showing the number of days charged to the contract for the preceding month and the number of days specified for completion of the contract. The contractor will be allowed 10 days in which to file a written protest setting forth in what respect said monthly statement is incorrect, otherwise the statement shall be deemed to have been accepted by the contractor as correct.

If a protest is filed by the contractor, the Department shall conduct such reviews and investigations as required to rule on the protest within 30 days from the date the statement is furnished the contractor. The number of days charged as listed, or revised within the above allotted time, shall become final at the end of this 30-day period, subject to change only through legal action.

When the contract time is on a calendar day basis, it shall consist of the number of calendar days stated in the contract beginning with the effective date of the engineer's order to commence work, including all Saturdays, Sundays, holidays and non-work days. All calendar days elapsing between the effective dates of any written orders by the engineer to suspend work and to resume work for suspensions not fault of the contractor shall be excluded.

When the contract completion time is a fixed calendar date, it shall be the date on which all work on the project shall be completed.

The number of days for performance allowed in the contract as awarded is based on the original quantities as defined in Subsection 102.05 and includes the time necessary to procure material, equipment and an adequate labor force to complete the work properly. If satisfactory fulfillment of the contract requires performance of work in greater quantities than those set forth in the proposal, the contract time allowed for performance shall be increased on a basis commensurate with the amount and difficulty of the added work.

If the contractor finds it impossible, for reasons beyond his control, to complete the work within the contract time as specified or as extended in accordance with the provisions of this Subsection he may, at any time prior to the expiration of the contract time as extended, make written request to the engineer for an extension of time setting forth therein the reasons which he believes justify granting his request. The contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the engineer

finds that the work was delayed because of conditions beyond the control and without the fault of the contractor, he may extend the time for completion in such amount as conditions justify. The extended time for completion shall be in full force and effect as though it were the original time for completion.

When final acceptance has been made by the engineer as prescribed in Subsection 105.17, the daily time charge will cease.

108.08 FAILURE TO COMPLETE ON TIME. For each calendar day or work day, as specified, that any work shall remain uncompleted after the contract time specified for the completion of the work required by the contract, the sum specified below will be deducted from any money due the contractor not as a penalty but as liquidated damages. Due account shall be taken of any adjustment of the contract time for completion of the work granted under the provisions of Subsection 108.07.

Permitting the contractor to continue the work after expiration of the contract time or extended contract time will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

The Department may waive such portions of the liquidated damages as may accrue after the work is in condition for safe and convenient use by the traveling public.

Based on the amount of the original contract, the following charges per contract day will be made for each such day after expiration of the contract time or extended contract time.

When the contract time is on either the calendar day or fixed calendar date basis, the schedule for calendar days shall be used. When the contract time is on a working day basis, the schedule for working days shall be used.

ORIGINAL CONTRACT AMOUNT		DAILY CHARGE	
From More Than	To and Including	Calendar Day or Fixed Date	Working Day
$ 0	$ 25,000	$ 30.00	$ 42.00
25,000	50,000	50.00	70.00
50,000	100,000	75.00	105.00
100,000	500,000	100.00	140.00
500,000	1,000,000	150.00	210.00
1,000,000	2,000,000	200.00	280.00
2,000,000	.....	300.00	420.00

The amount of liquidated damages will be deducted from any money due the contractor under this contract, and the contractor and his surety shall be liable for any liquidated damages in excess of amounts due the contractor.

108.09 DEFAULT AND TERMINATION OF CONTRACT. The engineer will give written notice to the contractor and his surety that the con-

tractor may be placed in default if he:

(a) Fails to begin the work under the contract within the time specified in the "Notice to Proceed," or

(b) Fails to perform the work with sufficient workmen, equipment or materials to assure prompt completion of said work, or

(c) Performs the work unsuitably or neglects or refuses to remove materials or perform anew any work rejected as unacceptable, or

(d) Discontinues prosecution of the work, or

(e) Fails to complete the project within the contract time or extended contract time, or

(f) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

(g) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or

(h) Allows any final judgment to stand against him unsatisfied for a period of 10 days, or

(i) Makes an assignment for the benefit of creditors, or

(j) For any other cause, fails to carry on the work in an acceptable manner.

If the contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, the Department will, upon written notification from the engineer to the contractor and surety of the fact of such delay, neglect or default and the contractor's failure to comply with such notice, have full power and authority without violating the contract to take the prosecution of the work out of the hands of the said contractor. The Department may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the engineer will be required for the completion of said contract in acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due said contractor. If such expense exceeds the sum which would have been payable under the contract, the contractor and the surety shall be liable and shall pay to the Department the amount of such excess.

108.10 TERMINATION OF CONTRACTOR'S RESPONSIBILITY. The contract will be considered complete when all work has been satisfactorily completed, the final inspection made and the work accepted by the Chief Engineer. The contractor will then be released from further obligation

except as set forth in his contract bond, and except as provided in Subsection 107.22.

108.11 TERMINATION OF CONTRACT. The Department will terminate the contract or portion thereof by written notice when the contractor is prevented from proceeding with the contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense, or by court order.

When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the contractor.

Acceptable materials, obtained or ordered by the contractor for the work and that are not incorporated in the work shall, at the option of the contractor, be purchased from the contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the engineer.

Termination of a contract or a portion thereof shall not relieve the contractor of his responsibilities for the completed work, nor shall it relieve his surety of its obligation for and concerning any just claim arising out of the work performed.

Section 109

Measurement and Payment

109.01 MEASUREMENT OF QUANTITIES. All work completed under the contract will be measured by the engineer according to United States standard measure.

The engineer shall be the judge as to the accuracy of any measurements or any approximations made in lieu of accurate determinations and his decisions shall be binding upon both parties.

When specified, pay quantities will be the design lengths, volumes, areas or weights as specified in the contract plans with adjustments thereto.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the engineer.

A station when used as a definition or term of measurement will be 100 linear feet.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

All items which are measured by the linear foot, such as pipe culverts, underdrains, etc., will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise specified.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be measured in decimal fractions of inches.

The term ton will mean the short ton consisting of 2,000 pounds avoirdupois. All materials which are measured or proportioned by weight shall be weighed on accurate, approved scales by competent, qualified personnel at locations designated by the engineer. If material is shipped by rail, the car weight may be accepted provided the actual weight of material only will be paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty at such times as the engineer directs, and each

truck shall bear a plainly legible identification mark.

Materials specified to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and shall be measured therein at the point of delivery. Vehicles may be of any size or type acceptable to the engineer, provided the body of the vehicle is of such shape that the actual volume or capacity may be readily and accurately determined. All vehicles shall be loaded to at least a predetermined permanently fixed mark, which defines a known volume or capacity, upon arrival at the point of delivery. No vehicle will be approved unless its capacity, or the volume below the predetermined permanently fixed mark, is in multiples of 0.5 cubic yard; except that when tail-gate spreader-boxes are used to place aggregate materials under Section 505, Asphaltic Surface Treatment, the volume of the spreader-box will be added to the volume of the vehicle.

Whenever possible and unless otherwise specified, pay quantities will be the designed volumes, areas or weights as specified in the contract plans and adjustments thereto.

Asphaltic materials will be measured by the gallon or by the ton.

Volumes of liquid asphaltic materials will be measured at 60°F, or will be converted to the gallonage at 60°F in accordance with the conversion tables in Section 506.

Net certified scale weights or weights based on certified volumes in the case of shipments by rail, truck or other transport will be used as a basis of measurement, subject to correction when material has been lost in transit, wasted or otherwise not incorporated in the work.

When asphaltic materials are shipped by truck or transport, net certified weights or volume, subject to correction for loss or foaming, may be used for computing quantities.

Portland cement will be measured by the barrel, ton or hundredweight (CWT). The term barrel will mean 376 pounds of cement.

Timber will be measured by the thousand feet board measure (MFBM) incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the contract.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

Rental of equipment will be measured by the time in hours of actual working time and necessary traveling time of the equipment within the limits of the project unless special equipment has been ordered by the engineer in connection with force account work in which case travel time and transportation

to the project will be measured. If equipment has been ordered held on the job on a standby basis by the engineer, half time rates for the equipment will be paid.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gage, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

If conversion is necessary from United States standard units to International System of Units (SI units) or from SI units to U.S. standard units the guidelines, terminology, conversion factors and rules for rounding in the Standard Metric Practice Guide, AASHTO Designation: R 1 will be used.

109.02 SCOPE OF PAYMENT. The contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials and for performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage or expense arising out of the nature of the work or the prosecution thereof, subject to the provisions of Subsection 107.22.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item.

109.03 COMPENSATION FOR ALTERED QUANTITIES. When accepted quantities of work vary from the quantities in the bid schedule, the contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the accepted quantities of work done. No allowance, except as provided in Subsection 104.02, will be made for any increased expense, loss of expected reimbursement or loss of anticipated profits suffered or claimed by the contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursements therefor or from any other cause.

109.04 EXTRA AND FORCE ACCOUNT WORK. Extra work performed in accordance with Subsection 104.03 will be paid for at the unit prices or agreed prices stipulated in the order authorizing the work or the Department may require the contractor to do such work on a force account basis, to be compensated in the following manner:

(a) Labor: For all labor and working foremen in direct charge of the specific operations, the contractor shall receive the rate of wage (or scale) agreed upon in writing before beginning work for each hour that said labor

and foremen are actually engaged in such work.

The contractor shall receive the actual costs paid to, or in behalf of, workmen by reason of subsistence and travel allowances, health and welfare benefits, pension fund benefits or other benefits when such amounts are required by collective bargaining agreement or other employment contract generally applicable to the classes of labor employed on the work, but limited to a maximum daily rate for subsistency and travel allowances, which maximum will be agreed upon prior to incurring such charges.

An amount equal to 20 percent of the sum of the above items will also be paid the contractor.

(b) Bond, Insurance and Tax: For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the contractor shall receive the actual cost thereof, to which 6 percent will be added. The contractor shall furnish satisfactory evidence of the rates paid for such bond, insurance and tax.

(c) Materials: For materials accepted by the engineer and used, the contractor shall receive the actual cost of such materials delivered on the work including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost 15 percent will be added.

(d) Equipment: For any machinery or special equipment (other than small tools) including fuel, lubricants and transportation costs, the use of which has been authorized by the engineer, the contractor shall receive the rental rates agreed upon in writing before such work is begun for the actual time such equipment is in operation on the work.

(e) Miscellaneous: No additional allowance will be made for general superintendence, the use of small tools or other costs for which no specific allowance is herein provided.

(f) Compensation: The contractor's representative and the engineer shall compare records of the cost of work done as ordered on a force account basis. Such comparison shall be made daily if required by the engineer. Should any work be performed by an approved subcontractor, the contractor shall be paid the actual and reasonable cost of such subcontracted work computed as outlined above, plus an additional allowance of 5 percent for materials cost and for direct labor cost to cover the contractor's profit, superintendents, administration, insurance and overhead.

(g) Statements: No payment will be made for work performed on a force account basis until the contractor has furnished the engineer with duplicate itemized statements of the cost of such force account work detailed as follows:

(1) Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.

(2) Designation, dates, daily hours, total hours, rental rate and extension for each unit of machinery and equipment.

(3) Quantities of materials, prices and extensions.

(4) Transportation of materials.

(5) Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and social security tax.

Statements shall be accompanied and supported by invoices for all materials used and all transportation charges. If materials used on force account work are not purchased for such work but are taken from the contractor's stock, in lieu of invoices, the contractor shall furnish an itemized list of such materials showing that the quantity claimed was actually used, and that the price and transportation costs claimed represent the actual cost of the contractor. All invoices submitted shall be accompanied by the contractor's notarized statement that payment in full has been made for the materials.

109.05 ELIMINATED ITEMS. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the engineer may, upon written order to the contractor, eliminate such items from the contract and such action shall in no way invalidate the contract. When a contractor is notified of the elimination of items, he will be reimbursed for actual authorized work done and all costs incurred, including mobilization of materials prior to said notification.

109.06 PARTIAL PAYMENTS AND RETAINAGE ESCROW OPTION. Provided work is prosecuted in accordance with the provisions of the contract and with such progress as satisfactory to the engineer, the engineer will make or cause to be made, the first progress estimate within two calendar months from the date indicated to begin work in the "Notice to Proceed." Each successive progress estimate will be made on this same date of each month thereafter until completion of the contract. Each progress estimate will be an approximation of the proportionate value of the work performed up to and including the date the estimate is made and will be based on material in place and labor expended thereon, but no more than 95 percent of the contract price of the work will be paid in advance of full completion of the contract and its acceptance by the Department. In lieu of the retained funds being held by the Department as stated herein, the contractor has the option of requesting the Department to establish an escrow account in accordance with the provisions of Louisiana Revised Statutes 48:256.1 (Act 661 of 1975). If the contractor desires to have the Department place the retained funds under this contract in an escrow account, the "Retainage Escrow Option Statement" provided in contract documents must be executed.

The amount of said estimate, after deducting 5 percent and all previous payments, shall be due and payable to the contractor.

The monthly estimates will be approximate and all partial or monthly estimates and payments shall be subject to corrections in the estimate rendered following discovery of any error in any previous estimates.

Should any defective work or material be discovered or should a reasonable doubt arise as to the integrity of any part of the work completed previous to the final acceptance and payment, there will be deducted from the first estimate rendered after the discovery of such defective or questioned work an amount equal in value to the defective or questioned work, and this work will not be included in a subsequent estimate until the defects have been remedied or the causes for doubt removed.

The payment of the monthly estimate shall not be taken as an admission that the work is done or that its quality is satisfactory nor as a release of the contractor from the responsibility for any portion thereof, but the whole work and all particulars relating thereto shall be subject to revision and adjustment by the engineer at the time of final acceptance and the payment of the final estimate.

109.07 PAYMENT FOR MATERIAL ON HAND.

(a) General: When approved by the engineer, advance payments may be made for fabricated or natural materials that are to be incorporated in the project when such materials are stockpiled or stored on the project or in acceptable facilities outside the limits of the project or within the boundaries of the State of Louisiana. Payments shall be limited to those materials described herein that are durable in nature and must represent a significant portion of the project cost. Perishable articles and small warehouse items are not included. These materials must meet the specifications and partial payment for materials on hand will not constitute acceptance. It shall be the contractor's responsibility to protect the material from damage while in storage.

Payment for materials, unless otherwise stated in the specifications, may be the invoice price for the material. For fabricated materials purchased from commercial sources and delivered to approved storage, partial payment may be the invoice price plus freight and taxes. The quantity of material for payment will not exceed the total estimated quantity required to complete the project and the invoice values will not exceed the appropriate portion of the contract items in which such materials are to be incorporated.

The amounts advanced on stockpiled or stored materials will be recovered by the Department through deductions made on construction estimates and payments as the materials are incorporated in the work.

Partial payment must be requested by the contractor in writing and the following documents must be furnished before approval can be made:

(1) Written consent from the contractor's surety for the Department to

make such partial payment.

(2) A copy of the original invoices from the supplier or manufacturer verifying the cost and quantity of material.

(3) If storage is on private property, a copy of the lease or agreement granting the Department right of entry to property.

Payment for materials stored outside the boundaries of the State of Louisiana may be considered on an individual basis, subject to approval of the Chief Engineer. This will generally be limited to adjacent states, except in special cases where it will be in the best interest of the Department to pay for these materials. If payment for stockpiled materials outside the State boundaries will affect the bid price for a given item and a contractor desires a decision by the Chief Engineer prior to bidding, this can be done by making a request in writing giving all the details.

Within 30 days after payment by the Department, the contractor shall submit a copy of certified invoice statement for each item for which payment has been made and all such invoices submitted shall be accompanied by the contractor's notarized statement that payment in full has been made for the materials. If this certification of payment is not presented within the 30-day period, the advanced payment will be deducted from future progress payments.

Title and ownership of materials for which advancements have been made by the Department shall not vest in the Department until such materials are actually incorporated in the work and the work accepted by the Department and the making of advancements therefor by the Department shall not release the contractor from the responsibility for any portion thereof.

(b) Fabricated Material: This shall be fabricated or manufactured materials that are purchased by the contractor for a project and may include the following.

Structural steel, fabricated structural steel items, steel piling, reinforcing steel, electrical equipment, precast and precast-prestressed concrete items including pipe, piling, girders and bridge sections, structural timber, timber piling, fencing and guard rail materials including posts, fabricated sign structures and sign panels.

(c) Natural Material: These materials would normally be large quantities of aggregate (including fine aggregate, stone, gravel, expanded clay and shell) that are stockpiled for use in the project.

The contractor's request for payment of stockpiled natural material must give a detailed description of the material, its intended use and the location of the site. This material must be in approved stockpiles on the project or in the vicinity of the project and must be inspected and approved by the engineer in writing.

109.08 ADJUSTMENT FOR CHANGES IN COMMON CARRIER

RATES. It is understood and agreed that the accepted proposal for this project is based on common carrier rates on file with the Interstate Commerce Commission or with a corresponding intrastate commission or body and in effect on the date of opening of bids. Payments to the contractor will be adjusted upon request to compensate for increases in cost due to changes in common carrier rates becoming effective after the date of opening of bids and before the date stipulated for completion of the work, as adjusted because of authorized extensions of time. The adjustment shall be limited to an amount determined as follows:

The adjustment shall be the product of the increase in the said common carrier rates multiplied by the net quantity of material shipped at the new rates to the work and incorporated therein, all as shown by receipted common carrier bills.

If the freight cost by common carrier to the jobsite is included in the quotation by the supplier to the contractor, in addition to the receipted freight bills, the supplier shall furnish on each of his invoices a breakdown showing the freight rate, quantity of material and total freight cost, and the contractor shall furnish the supplier's written quotation made prior to the date of letting of the contract and shall further furnish a notarized statement that he has paid the increased freight rate.

This provision does not apply to any other than shipments by common carrier.

The contractor's request for payment adjustment due to increased common carrier rates shall be submitted as soon as possible after the total hauling for the project has been completed. Only one request for such payment adjustment shall be made for each project, and any payment adjustment due the contractor for increased common carrier rates will be included in the final estimate for the project. No request for such payment adjustment will be considered unless it is submitted to the Department, with the required receipted bills and forms, within 30 days after final acceptance of the project.

109.09 ACCEPTANCE AND FINAL PAYMENT. Upon completion and acceptance of the work, the Chief Engineer will execute a certificate that the whole work provided for in the contract has been completed and accepted under the terms and conditions of the contract and said certificate of acceptance will be recorded in the office of the Recorder of Mortgages of the parish in which the work has been done, and the entire balance found to be due the contractor, including all retained percentages, will be paid to the contractor after the Department has satisfied itself that the quantities shown on the final estimate are correct; however, before payment of said final estimate will be made, the contractor shall submit to the Department a certificate from the Recorder of Mortgages of the parish in which the work has been done to the effect that there are no claims or liens recorded against the said contract. The date of said certificate shall be not prior to the expiration of 45 days after the

certificate of acceptance was recorded by the Department in the Mortgage office.

Prior to payment of the final estimate, all releases or waivers on buildings, wells, utilities and railroads must be furnished as well as any maintenance bonds, certificates from Health Department, tracings, brochures or other items required by the contract.

Payment of the final estimate shall not operate to release the contractor or his sureties from liability for any fraud in construction, or in obtaining progress payments, or in payment for materials, labor or other supplies or services incidental to the work, or for any and all claims for damages, loss or injury sustained by any persons through the fault, negligence or conduct of the said contractor or any of his employees.

PART II

EARTHWORK

Section 201

Clearing and Grubbing

201.01 DESCRIPTION. This work consists of clearing, grubbing, removing and disposing of all vegetation and debris within the limits of the right-of-way and easement areas, except such objects that are designated to remain or that are to be removed in accordance with other Sections of these specifications. This work also includes the preservation from injury or defacement of all vegetation and objects designated to remain.

(a) Clearing and Grubbing. This consists of cutting timber, logs, brush, stumps and debris; excavation and removal of all stumps, roots, submerged logs, snags, corduroy and other perishable and objectionable material; and removing, burning and cleaning up the entire area to be cleared. Clearing and grubbing shall be done within the entire construction area and to a point in fills 15 feet beyond the toes of foreslopes and in cuts 15 feet beyond the tops of backslopes, when width of right-of-way permits, or to the limits shown on the plans; also from such areas required for outfall ditches and channel changes. Also, where fencing and/or utility relocation is required, it shall include an area 10 feet wide adjacent to and inside the right-of-way line. In addition, it shall include clearing of fruit trees, shrubbery and flowers within the above limits which are not removed by their owners, except shrubbery which is to be removed and transplanted by the contractor in connection with other bid items.

(b) Selective Clearing and Grubbing. This consists of selectively clearing areas within the limits of the right-of-way which are not included under "Clearing and Grubbing" of all non-valuable trees, shrubs, vines, logs, brush, stumps, snags and debris, for the purpose of leaving valuable vegetation to remain.

201.02 GENERAL CONSTRUCTION REQUIREMENTS. The engineer will establish right-of-way lines and construction lines and shall designate trees, shrubs, plants and other items to remain. The contractor shall preserve all items designated to remain. Equipment, materials and supplies will not be stored in the proximity of trees designated to remain. Trees shall be felled and removed in such manner as to avoid injury to other items marked to remain. In case of injuries to bark, trunks, limbs or roots of vegetation marked to remain, the contractor shall repair such damage without ad-

ditional compensation, by corrective pruning, bark tracing, wood painting and other acceptable horticultural and tree surgery practices. Trees falling outside the right-of-way limits shall be removed. When directed by the engineer, dead trees outside the limits of clearing and grubbing shall be cleared from the right-of-way.

201.03 CLEARING AND GRUBBING. Surface objects and all trees, stumps, roots and other protruding obstructions not designated to remain shall be cleared and/or grubbed including mowing as required except undisturbed stumps, roots and nonperishable solid objects which will be a minimum of 2 feet below subgrade or slope of embankments. When authorized, the contractor may leave stumps and nonperishable solid objects provided they do not extend more than 6 inches above the ground line or low water level.

Grubbing with explosives will not be permitted in swampy areas or adjacent to high pressure oil and gas lines without permission from the engineer.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled and compacted to the approximate density of the surrounding ground in accordance with Section 203.

If perishable material is burned, it hsall be burned under the constant care of competent watchmen at such times and in such manner that anything designated to remain on the right-of-way, the surrounding forest cover or other adjacent property will not be jeopardized. Burning shall be accomplished in accordance with all applicable laws and ordinances and in particular Section 11 entitled "Control of Air Pollution from Outdoor Burning" of the current regulations of the Louisiana Air Control Commission.

Materials and debris which cannot be burned and perishable materials which are not burned shall be removed from the right-of-way and disposed of at locations off the project outside the limits of view of the traveling public. The contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations and cost involved shall be included in the price bid. Copies of all agreements with property owners shall be furnished the engineer.

All merchantable timber in the clearing area which has not been removed from the right-of-way prior to the beginning of construction shall become the property of the contractor unless otherwise provided.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20 feet above the pavement surface. All trimming shall be done by skilled workmen in accordance with good tree surgery practices.

201.04 SELECTIVE CLEARING AND GRUBBING. Areas indicated on the plans to be selectively cleared and grubbed shall be cleared of all

trees and vegetation, except those selected to remain, and all stumps, rubbish and other perishable or objectionable matter. The contractor shall notify the engineer by letter at least 2 weeks in advance of the work to be done.

In order to facilitate the removal of trees, vegetation, etc., the following procedures shall apply:

(a) Except in instances as listed below in (b), spacing between trees to remain shall be approximately 50 feet. No attempt should be made to line up any trees. This is applicable to thick woods growth in order to give the contractor working space for equipment. The engineer should consider the kinds of trees to be marked with respect to their present spread and ultimate spread of tops in order to leave sufficient space.

(b) In exceptional instances where groups of trees or native shrubs are to be left standing, such groups may be left with closer spacing than stated in (a). Such closer spacing will be applicable to such trees and shrubs as pines, magnolias, and flowering trees—dogwood, redbud, holly (American and Yaupon), hawthorn and others which form upright growths or shrub effects.

Any trees found to be dead or dying in areas that have been selectively cleared, before the project is accepted, shall be removed by the contractor at his own expense.

201.05 METHOD OF MEASUREMENT. Measurement will be by the lump sum and no measurement of area will be made.

201.06 BASIS OF PAYMENT. When a pay item is included in the contract, clearing and grubbing will be paid for at the contract lump sum price. Partial payment will be limited to 5 percent of the original total contract amount until the contractor has earned 40 percent of the original total contract amount.

When the bid schedule does not contain an item for clearing and grubbing, the work will not be paid for directly, but will be considered as a subsidiary obligation of the contractor under other contract items.

Payment will be made under:

Item No.	Pay Item	Pay Unit
201(1)	Clearing and Grubbing	Lump Sum
201(2)	Selective Clearing and Grubbing	Lump Sum

Section 202

Removal of Structures and Obstructions

202.01 DESCRIPTION. This work consists of the removal and satisfactory disposal of all buildings, septic tanks, fences, culverts, structures, old pavement, abandoned pipe lines and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes and pits. If structures or obstructions are encountered which differ materially from those ordinarily encountered or generally recognized as inherent for the work, the provisions of Subsections 104.02, 104.03 and 105.18 will be considered.

202.02 CONSTRUCTION REQUIREMENTS. The contractor shall remove and dispose of all buildings and foundations, fences and other obstructions, any portions of which are on the right-of-way, except utilities and those items for which other provisions have been made for removal. When specified, the contractor shall remove building foundations, slabs and appurtenances that extend beyond the right-of-way line or that are entirely on private property. The contractor is cautioned to keep off private property except in these areas. All designated salvageable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported and shall be stacked at specified storage areas by the contractor within the project limits or hauled to a designated maintenance storage yard and stacked. All materials designated not to be salvaged shall be destroyed or disposed of off the project outside the limits of view of the traveling public with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished the engineer. Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the limits of construction, shall be compacted to the approximate density of the surrounding ground.

202.03 REMOVAL OF BRIDGES, CULVERTS AND OTHER DRAINAGE STRUCTURES. Bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, substructures of existing structures shall be re-

moved down to the natural stream bottom and those parts outside of the stream shall be removed down to one foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accomodate the construction of the proposed structure.

Steel bridges and wood bridges to be salvaged shall be carefully dismantled without unnecessary damage. This dismantling shall include the stripping of all hardware and the removal of all nails. Steel members shall be match marked before dismantling unless otherwise indicated. All salvaged material shall be stored or removed as specified in Subsection 202.02.

Blasting or other operations necessary for removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

202.04 REMOVAL OF PIPE. Unless otherwise provided, all pipe to be salvaged shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe. Pipes to be relaid shall be removed and stored so that there will be no loss or damage before relaying. The contractor shall replace sections lost from storage or damaged by negligence or by use of improper methods. Pipes not to be relaid and considered usable shall be salvaged, cleaned of soils or other materials, stored or removed and stacked as specified in Subsection 202.02.

202.05 REMOVAL OF PAVEMENT, SIDEWALKS, CURBS, ETC. Unless otherwise specified, all concrete pavement, base course, sidewalks, curbs, gutters, etc., designated for removal, shall be disposed of outside the right-of-way and beyond the limits of view of the traveling public in accordance with Subsection 202.02.

202.06 METHOD OF MEASUREMENT. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include all required removal of structures and obstructions. Where the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

If the contract does not include pay items for removal of structures and obstructions, the removal work will be considered incidental and will not be measured for separate payment.

Hauling salvaged material will be measured by the lump.

202.07 BASIS OF PAYMENT. The accepted quantities of removal of structures and obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removing and disposing of the obstructions.

Specific obstruction items, stipulated for removal or disposal under unit price pay items will be paid for at the contract price per unit specified in the

contract, which price shall be full compensation for removal and disposal of such items, excavation and subsequent backfill incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage on the right-of-way and disposal.

When an item for hauling salvaged material is provided, the hauling of such material to the designated maintenance storage yard will be paid for at the contract lump sum price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
202(1)	Removal of Structures and Obstructions	Lump Sum
202(2)	Removal of _____	Each, Linear Feet, Lump Sum, Square Yard
202(3)	Hauling Salvaged Material	Lump Sum

Section 203

Excavation and Embankment

203.01 DESCRIPTION. This work consists of excavation, disposal, placement and compaction of all materials that are not provided for under other Sections of these specifications, including excavation and embankment construction for roadways and other structures, excavation for ditches and channels, and all other grading operations necessary for the construction work in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer.

The plans may include data regarding the boring and classification of existing roadway materials. The Department does not guarantee the accuracy of such information shown on the plans and bidders should make, at their own expense, such additional investigations as they consider necessary. No additional payment will be made for any increased costs due to inaccuracy of soil boring data shown on the plans.

The contractor's attention is directed to the requirements of Section 107.09 for work in or adjacent to navigable waters and wetlands.

203.02 UNCLASSIFIED EXCAVATION. Unclassified excavation consists of the excavation and disposal of all materials encountered within the highway right-of-way in the course of construction not otherwise classified and paid for under other items.

203.03 DRAINAGE EXCAVATION. Drainage excavation includes all excavation made for the primary purpose of facilitating drainage beyond the limits of the roadway section except for wing ditches at cuts. Drainage excavation also includes inlet and outlet ditches to structures or roadway; changes in or deepening of channels of streams, berm ditches, ditches parallel to or adjacent to the roadway beyond the limits of the roadway section; and material excavated from areas under bridges.

203.04 MUCK EXCAVATION. Muck excavation consists of the removal of deposits of mixtures of soils and organic matter not usable for foundation material. Muck shall include materials which will decay or produce unsatisfactory subsidence in the embankment and may be made up of decaying stumps, roots, logs, humus, or other material not satisfactory for incorporation in the embankment. The engineer will determine the material to be

classified as muck and wasted and the material that is satisfactory for use in the embankment.

203.05 BORROW. Borrow is defined as usable materials required for the construction of embankments or for other portions of work, in excess of the quantity of usable material available from required excavations and obtained from an approved source. Unless otherwise designated in the contract or on the plans, the contractor shall make his own arrangements for obtaining borrow at no additional expense to the Department. Borrow may be required even though not shown on the plans.

Borrow material shall be tested and classified by the Laboratory before being placed in embankments.

Securing of exclusive option by any contractor on borrow areas or materials for the work to be done will be interpreted as a violation of Section 423 of Title 48 of the Louisiana Revised Statutes of 1950 and will be a basis for rejection of bids or such other action the Department deems advisable.

Borrow pits, except as specified in Subsection 203.13, shall be located a minimum distance of 300 feet from the right-of-way, unless otherwise authorized in writing by the engineer. In instances where pits are located closer than 300 feet and are visible from the roadway, they shall be screened in accordance with Department requirements at no additional cost to the Department.

When sources of borrow are located adjacent to a stream or river listed on the National System of Wild and Scenic Rivers or the Louisiana Natural and Scenic Rivers System, the borrow pits, and any stockpiled materials, shall be located not less than 300 feet from the natural bank of the stream.

203.06 USABLE MATERIAL. Usable material is defined as material whose composition is designated satisfactory for use in embankment construction. The moisture content has no bearing upon such designation.

All materials designated usable and to be placed in embankments, whether from required excavations or borrow excavation, shall have been tested and classified in their original position by the Laboratory before being excavated and placed in the embankment or other final positions on the project and shall be subject to the restrictions for materials hereinafter contained, shall be soils conforming to DOTD Designation: TR 423 Classes A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-3, A-4, A-5, A-6, A-7-5 and/or A-7-6, except that material in the A-5, A-6, A-7-5 and A-7-6 classes considered unusable by the engineer will not be accepted.

Lime treatment of soils for the convenience of the contractor may be allowed when approved by the engineer and at no additional cost to the Department. Lime treatment of embankment materials may be specified in accordance with Section 304.

Should a material of the A-1-b class (Coarse sand or gravelly sand) or A-3

class (Sand) be used, the contractor, when directed by the engineer, will be required to use on the slopes a plastic material of the A-4, A-6, A-7-5 and/or A-7-6 classification, with a minimum Plasticity Index of 10 and must support vegetation. The compacted thickness of the plastic material shall be at least 6 inches.

When "Selected Materials" are specified, the materials furnished shall be soils conforming to DOTD Designation: TR 423 Classes A-1-a, A-1-b, A-3, A-2-4, A-2-6, A-4 or A-6 having a maximum Liquid Limit of 35 and a maximum Plasticity Index of 15.

"Special Embankment (Nonplastic)" borrow material shall be as specified in Subsection 203.14 unless amended by the project specifications.

The contractor shall notify the engineer in writing at least 15 days in advance of borrow operations so that samples may be taken and soil tests completed prior to beginning the excavation. The contractor will not be permitted to begin the borrow operations until soil tests have been completed and materials approved for use.

203.07 UNUSABLE MATERIAL. Any material containing vegetable or organic matter, such as muck, peat, organic silt, topsoil or sod, shall be considered unsuitable for use in embankment construction. This material, when approved by the engineer as adequate to support vegetation, may be used on the embankment slopes.

203.08 EMBANKMENT. The embankment is defined as the portion of a fill section situated between the embankment foundation and the subgrade surface.

203.09 EMBANKMENT FOUNDATION. The embankment foundation is defined as the surface upon which an embankment is constructed after all required preparatory work has been completed.

203.10 EMBANKMENT CONSTRUCTION CONTROL DEVICES. This work shall consist of furnishing, installing and maintaining devices such as settlement gages, settlement stakes, piezometers and other equipment used specifically for monitoring earthwork construction.

203.11 GENERAL CONSTRUCTION REQUIREMENTS. Excavation and embankments for the roadway, intersections and entrances shall be finished to reasonably smooth and uniform surfaces. Excavation operations shall be so conducted that material outside of the limits of construction will not be disturbed. Prior to beginning excavation, grading and embankment operations in any area, all necessary clearing and grubbing in that area shall have been completed.

Drainage excavation and rough grading shall be performed simultaneously, unless otherwise directed. Drainage excavation may be disposed of or placed in the embankment, unless otherwise specified. Roots, stumps and

other obstructions in sides and bottom of ditches and channel changes shall be cut to conform to required cross section and grade. No excavated material shall be left within 3 feet of the edge of ditch or channel.

When obliteration of old roadways is required, it shall include all grading operations necessary to incorporate the old roadway into the new roadway and surroundings in order to provide a pleasing appearance from the new roadway. Unless otherwise specified, roadway obliteration will be paid for as unclassified excavation.

When the contractor's excavating operations encounter cultural artifacts or archaeological, historical or paleontological sites, the operations shall be temporarily discontinued. The engineer will contact the proper authorities in order that an appropriate assessment may be made to determine the disposition thereof and any necessary actions that may be required relative to the site. When directed, the contractor shall excavate the site in such manner as to preserve the artifacts encountered. Such excavation will be measured and paid for as extra work, including an appropriate adjustment in contract time.

In preparation of the natural ground to receive embankment material or preparation of the finished section in a cut area on which fill or base materials are to be placed, the contractor shall diligently attempt all normal earthwork construction methods before undercutting will be considered by the Department.

The construction methods should include, but are not limited to, the following.

(a) Draining and drying of the surface area until the material is within reasonable limits of optimum moisture before any compaction is attempted.

(b) Using lighter construction equipment for manipulation, disking, drying and compaction of the material.

(c) The lower part of the embankment may be constructed by dumping successive loads of material in a uniformly distributed layer of a thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

(d) Reroute heavy construction equipment around the area until the embankment can support this equipment without damage to foundation soils.

When unusable or collapsible soils are present, these areas will be defined and the unstable material shall be removed by undercutting, and the areas backfilled to the required section with approved material as directed.

If undercutting is required, the contractor shall conduct his operations in such manner that the engineer can make the necessary measurements before the backfill is placed. Undercut will be paid for as unclassified excavation.

and the required usable material for backfilling will be paid for as embankment.

203.12 NONHYDRAULIC EMBANKMENT CONSTRUCTION. Embankment construction consists of constructing roadway embankments, including preparation of the areas upon which they are to be placed; constructing dikes, when required; placing and compacting of approved material in areas where unusable material has been removed; placing and compacting embankment material in holes, pits and other depressions within the roadway area; and placing and compacting embankment material for backfilling structures. Only approved materials shall be used in embankments and backfills.

The contractor shall be responsible for the stability of all embankments constructed under the contract until final acceptance of the work and shall bear the expense of replacing any portions which have become displaced due to carelessness or negligent work on the part of the contractor, or to damages resulting from natural causes, such as rainfall, etc., and not attributable, in the opinion of the engineer, to unavoidable movements of the ground upon which the embankment is constructed.

Rocks, broken concrete or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

When embankments are constructed on a hillside sloping more than 6:1 from the horizontal, the slope of the ground on which the embankment is to be placed shall be plowed or cut into steps before the fill is placed. Where a new road is to be constructed on an existing road, it shall be plowed or scarified and broken up full width to a depth of not less than 6 inches and recompacted as directed.

Unless otherwise specified, where an embankment is to be constructed to a height of 3 feet or less, heavy sod and objectionable vegetable matter shall be removed from the surface upon which the embankment is to be placed and the cleared surface shall be completely broken up by plowing, scarifying or stepping to a depth of approximately 6 inches. This area shall be recompacted to the approximate density of surrounding ground. When height of fill is greater than 3 feet, sod not required to be removed shall be thoroughly disked and recompacted to the approximate density of surrounding ground before construction of embankment.

If embankment material is to be deposited on one side only of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. Unless otherwise indicated, the fill adjacent to the end bent of a bridge shall not be placed higher than the top of the substructure until the superstructure is in place. When the embankment is to be deposited on both sides of a concrete wall or similar type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the

structure. Backfilling of structures to natural ground shall be performed as outlined in Subsection 203.16.

All excess or unusable excavated material, including rock and boulders, that cannot be used in embankments, when permitted, may be placed on the side slopes of the nearest fill or berm in a satisfactory manner and shall be placed so as to maintain a distinct shoulder line by keeping all such waste material the specified distance below the finished shoulder. If it is impossible to dispose of all such material in the manner described, the remainder shall be satisfactorily disposed of beyond the limits of the right-of-way.

Roadway embankment of earth material shall be placed in layers approximately parallel to the finished grade line not exceeding approximately 12 inches thick (loose measurement). Each layer shall be placed for the full width of the embankment, mixed to a reasonably uniform moisture content and compacted before the next layer is placed. Suitable spreading equipment shall be used on each layer to obtain reasonably uniform thickness and section prior to compacting. As compaction of each layer progresses, necessary spreading and manipulating will be required to assure uniform density. The operations shall be conducted in such manner as to obtain proper bonding between layers. Water shall be added or removed as necessary to obtain the required density.

When embankments are constructed through or into lakes, streams, swamps or other unstable areas that do not afford a satisfactory foundation for embankments and the unstable material cannot be economically removed, or the area drained, the requirement for placing material in layers as outlined above may be waived in these areas and the embankment placed by end dump or other approved methods to an elevation where it is determined that normal construction methods can begin. This elevation shall be determined by the engineer during construction. Material placed below this determined elevation shall be compacted in accordance with Subsection 203.16. Embankments placed above this determined elevation shall be constructed in approximately 12-inch layers as specified in the preceding paragraph.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces resulting from excavation method, such material may be placed in the embankment in layers not exceeding in thickness the approximate average size of the larger rocks. Each layer shall be leveled and smoothed with suitable equipment. The layers shall not be constructed above an elevation 2 feet below the finished subgrade. Rock fills placed in this manner shall be compacted in accordance with Subsection 203.16. The remaining embankment shall be constructed of approved material placed in layers not exceeding approximately 12 inches in loose thickness and compacted as specified for embankments.

When embankments consist of nonplastic material placed without density control, the top 12 inches of the embankment shall be compacted with vibratory equipment to 95 percent of maximum density in accordance with Subsection 203.14.

203.13 HYDRAULIC EMBANKMENT CONSTRUCTION. Hydraulic embankments shall be constructed of acceptable materials dredged and pumped from approved sources, shaped to reasonably conform to the lines, grades and cross sections indicated on the plans.

Hydraulic methods will only be allowed when nonplastic materials are used. Acceptable nonplastic material shall be that specified under Subsection 203.14 or as specified in the project specifications.

Unless otherwise provided, the contractor must procure all necessary permits from the proper authorities to operate in waters under their control. He shall also obtain all necessary permits for passage of discharge pipe over private property.

Dredging and other equipment adequate to assure completion of project shall be furnished and shall be subject to approval.

If information is shown on the plans indicating the availability of material suitable for hydraulic embankment, the Department does not guarantee the depth, extent and character of the material so indicated. Bidders should make, at their own expense, such additional investigations as they consider necessary. No additional compensation will be allowed should it develop that the material is of a different nature from that indicated.

No material shall be obtained from sources closer than 500 feet from the toe of the slope of the embankment shown on plans, unless otherwise permitted. Unusable material shall be removed from the borrow area before embankment material is removed. All muck and unusable material shall be removed from the embankment area to the line, grade and section shown on the plans. Any muck or other unusable material entrapped or brought to the top of the embankment shall be removed. Placement of material in the embankment shall begin at the centerline and then proceed in either or both directions towards the toes of the slopes and the discharge shall always be along and parallel to the centerline, unless otherwise permitted. Method of discharge shall not cause erosion or damage to property of others. Material shall be deposited in such manner as to maintain a higher elevation at the center. Retaining levees along highways that may cause damage will not be permitted. Operations shall be conducted in such manner that will insure completion of the embankment in reasonable conformity with the cross sections shown on plans except that flatter side slopes will be permitted at no cost to the Department. However, if material is deposited on private property, written permission from the owners must be secured by the contractor. All necessary precautions shall be taken to prevent filling existing streams and waterways in accordance with Subsection 204.02. The contractor assumes all respons-

ibility for compression, subsidence, displacement or slides that may take place in the hydraulic fill, and no payment will be made for materials outside the limits of the net pay section. Where discharge pipelines cross the surface of an existing highway, they shall be bridged in a satisfactory manner, and traffic shall be properly protected by warning signs and/or signals at all times. Any damage done to existing highway facilities due to the contractor's operations shall be repaired by the contractor at his expense.

203.14 CONSTRUCTION OF SPECIAL EMBANKMENT (NON-PLASTIC). This method shall consist of constructing embankments with or without surcharge, and subsequently removing and disposing of surcharge materials, when required, in accordance with the plan details and locations, and these requirements.

Unless otherwise specified, embankment materials shall be either sand, shell, gravel or any combination thereof. The foreign matter content and material passing the No. 200 sieve shall not exceed a total of 15 percent by dry weight.

If 75 percent or more passes the No. 4 sieve, the material may be placed without lift thickness requirements. If less than 75 percent passes the No. 4 sieve, the material shall be placed in 12-inch thick lifts (loose) after establishing a working table as directed by the engineer. Embankment material shall be placed in such manner as to avoid entrapment of muck, and the contractor shall remove any trapped muck. The engineer will make periodic tests of embankment material at the point of delivery on the project to ascertain conformance with these requirements.

The contractor shall have the option of constructing the embankment by hydraulic methods as modified herein.

The embankment with surcharge will be approved by the engineer in increments of 1,000 linear feet, except terminal increments which may be less than 1,000 feet. Surcharge materials shall be allowed to remain on the embankment for at least the number of days specified on the plans or in the project specifications after approval of the increment. Any damage to embankment increments due to the contractor's operations shall be satisfactorily repaired by the contractor at his own expense.

It is anticipated that no major embankment settlement will occur after the specified surcharge period; therefore, the contractor will be permitted to remove excess surcharge materials after the surcharge period. Verification cross sections of the final embankment will be taken within 90 days after removal of the surcharge, and the Department will assume all liability for subsidence after these sections are taken. After all embankment increments have been surcharged, all excess surcharge material not used in embankments shall be satisfactorily disposed of outside the right-of-way, unless otherwise specified.

As soon as possible after removal of surcharge materials, the contractor shall furnish and place a protective soil blanket that will support adequate vegetation on embankment slopes. Unless otherwise specified, the thickness of the completed soil blanket shall be 6 inches. Protective blanket materials shall be approved materials from unclassified, drainage or muck excavation and/or other approved sources. Embankment areas to be protected shall be approved by the engineer prior to placement of the protective blanket. After placing and spreading of the material, all lumps, stones, roots and other foreign matter shall be removed from the area. Blanket material shall be compacted to the required depth with a cultipacker or by other approved methods. No direct payment will be made for furnishing and placing protective soil materials, unless otherwise provided.

After removal of surcharge materials and prior to taking final verification cross sections, the top of the embankment shall be compacted by means of vibratory rollers in accordance with the following. The vibratory rollers shall be approved types capable of reversing without backlash and having separate controls for energy and propulsion. The top 12 inches of the embankment shall be compacted with the vibratory roller to 95 percent of the maximum density determined on the job by the engineer by means of a 500-foot test section compacted with the vibratory roller as directed by the engineer. If the surface of the embankment tends to loosen during vibratory rolling, the loosened material shall be compacted with a nonvibratory roller to the required density.

203.15 COMPACTION OF EMBANKMENT AND CUT AREAS WITH DENSITY CONTROL. Unless otherwise provided, all embankments are to be constructed with density control.

In cut areas, for the full width of roadbed, the top 6-inch layer on which fill or base materials is to be placed shall be thoroughly scarified and the moisture content increased or reduced as necessary. This 6-inch layer shall then be compacted to not less than 95 percent of the maximum density.

All material in embankments requiring density control shall be placed in layers not to exceed 12 inches uncompacted thickness, and shall be compacted to not less than 95 percent of maximum density. At the option of the contractor, approximately the top 2 inches of intermediate layers may be compacted in conjunction with the next succeeding layer. The 2-inch layer of the previous lift shall be dried or moistened to be within reasonable limits of optimum moisture before hauling the subsequent lift.

Compaction of embankments may be accomplished by any satisfactory method that will obtain the required density, unless otherwise specified.

Dumping and rolling areas shall be kept separate and no layer shall be covered by another until density complying with the requirements of this Subsection is secured.

Maximum density will be determined in accordance with DOTD Designation: TR 418 and the in-place density determined by DOTD Designation: TR 401. The frequency for density testing will be a minimum of one test per lift per roadway in each 1,000-foot zone.

203.16 COMPACTION OF EMBANKMENTS WITHOUT DENSITY CONTROL. Except for rock fills, sand fills below the water table and the first layer of fills over unstable areas, embankment materials shall be deposited in layers not exceeding approximately 12 inches uncompacted thickness and compacted in such manner as to result in a satisfactory embankment. Compacting equipment and methods employed for the entire depth of the embankment shall be sufficient to obtain not less than 90 percent of maximum density in the top layer of such embankment.

Embankments constructed of rock fills, sand fills placed in water and in the first layer of fills constructed through or into lakes, streams, swamps and other soft areas shall be constructed and compacted in such manner as to permit construction of superimposed layers as specified. These materials shall be placed in accordance with Subsections 203.12 and 203.13.

203.17 SUBGRADE. All materials that will not satisfactorily compact shall be removed and replaced with usable material and the subgrade, for its entire width, shall be brought to line and grade within reasonable limits and compacted to uniform density. Where the subgrade is of a nonuniform compacted nature or where required, it shall be scarified to a depth of not less than 6 inches for its full width and the material spread and compacted to a uniform density.

All submerged roots, stumps or other perishable matter encountered in the preparation of the subgrade shall be removed to a depth of not less than 2 feet below subgrade.

After the subgrade has been prepared as specified above, it shall be maintained in such condition as to drain. If damaged by hauling or handling materials, the subgrade shall be scarified and recompacted to required density. The subgrade shall be in final condition for receiving the base or surface for a distance of at least 500 feet in advance of placing subsequent courses. Subsequent courses shall not be placed until the subgrade has been approved by the engineer.

203.18 METHOD OF MEASUREMENT:

(a) General: Unless otherwise specified, the contract will provide pay items for excavation measured in accordance with Heading (b) and embankment measured in accordance with Heading (b).

All usable material from excavation items may be used in embankments or other finished sections of the project. All excavated material that is surplus or unusable shall be the contractor's property for disposal beyond the limits of the right-of-way.

Material required to construct embankments and other finished sections may be usable excavation material from the right-of-way or approved borrow material furnished by the contractor. No measurement or payment will be made for borrow material other than under the embankment item. The usable material from excavation items that is used in construction of embankments will not be subtracted from the total embankment quantity.

No measurement will be made of the usable material temporarily removed and replaced to facilitate compaction of the material for the full depth shown on the plans.

Water used will not be measured or paid for but will be incidental to the work.

Lime used will not be measured or paid for unless required by the plans or project specifications.

(b) Cubic Yard (Net Section) Measurement. When payment is specified by the cubic yard (net section), measurement for all excavation and embankment will be computed by the average end area method. The end area will be that bound by (1) the original ground line established by field cross sections and (2) the final theoretical pay line established by the excavation and embankment cross sections and other final sections shown on the plans; subject to verification in the field by the engineer in the following manner. The engineer, at his discretion and in accordance with established Departmental policy may use plan cross sections in lieu of re-cross sectioning to establish the existing ground line.

(1) Verification of Final Theoretical Pay Lines:

a. Muck Excavation: After completion of all muck excavation operations, final theoretical excavation lines will be verified by the engineer by means of field cross sections taken randomly at intervals not exceeding 1,000 linear feet and centerline elevations taken at intervals not exceeding 100 linear feet. Elevations for underwater mucking will be determined in accordance with DOTD Designation: TR 426.

A depth tolerance of 0.5 foot in mucked areas will be permitted, with a corresponding allowable width variation. Overdepth and overwidth will be waived at no additional cost to the Department, and no measurement for payment will be made for additional embankment material required to backfill areas beyond the theoretical muck lines.

b. Embankments and other Excavations: After completion of all excavation and embankment operations and prior to placing base course material, the final excavation and embankment will be verified by the engineer by means of field cross sections taken randomly at intervals not exceeding 1,000 linear feet and embankment centerline elevations not exceeding 100 linear feet.

Final excavation and embankment slope lines shall be uniform in appearance. If final excavation and embankment slope lines vary by more than 0.03 foot per linear foot of slope dip in embankments and 0.03 foot per linear foot of slope swell in excavations, measured from a straight line between the top of the embankment and the toe of the slope, the slopes shall be reworked by the contractor until the above criteria has been met. The top of the embankment shall not vary from the established grade by more than $\pm$ 0.1 foot.

Unless otherwise provided, the pay lines for surcharged embankments will be the theoretical surcharge lines shown on the plans. When removal of surcharge materials is required, no measurement for payment will be made for removing and disposing of the excess surcharge materials.

For any embankment item paid for in its final position, no additional quantity will be measured for payment to make up losses due to settlement, compaction, erosion or any other cause.

Unless otherwise provided, excavation and embankment for crossovers, turnouts, driveway approaches and other minor installations will be considered as incidental to the work and will not be included in the measurement for payment.

(2) Final Field Cross Sections: Final field cross sections in lieu of the final theoretical pay lines will be used to determine the pay quantity for excavation and embankment if the following changes are made by the engineer.

a. Plan widths of embankments or excavations are changed by more than $\pm$ 1.0 foot.

b. Plan elevations of embankments or excavations are changed by more than $\pm$0.5 foot.

Final field cross sections for the purpose of determining pay quantities will be employed only as stated above or where payment lines are not shown on the plans and cannot be reasonably established by the engineer.

(c) Linear Measurement: When it is specified that excavation and embankment is to be measured and paid for on a linear basis, the length will be measured in stations of 100 linear feet.

The measurement and payment includes performing all excavation, embankment and grading work necessary for the construction of the projects in accordance with the plan details and the requirements of this Section. It is the contractor's responsibility to determine the quantities of earthwork necessary to complete this item. The contractor shall dispose of any excess excavation beyond the limits of the highway right-of-way unless otherwise specified.

If an item for borrow material is not included in the contract, all necessary borrow material will be furnished and paid for under this linear measurement item.

(d) Lump Sum Measurement: When it is specified that excavation and embankment be measured by the lump sum, this item includes performing all excavation, embankment and grading work necessary for the construction of the project in accordanc with the plan details and the requirements of this Section. It is the contractor's responsibility to determine the correct quantities of earthwork required to complete this item. No adjustment in the contract price will be made due to errors in any estimated earthwork quantities shown on the plans. The contractor shall dispose of any excess excavation beyond the limits of the right-of-way. Payment for all required borrow material will be included in the contract price for this item.

(e) Vehicular Measurement: When it is specified that an item be measured by vehicular measure, the material will be measured by the cubic yard in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

(f) Measurement of Pay Items: Unless otherwise specified on the plans or in the project specifications, these items will be measured as follows:

(1) Item 203(1), Unclassified Excavation: Quantities will be in cubic yards (net section), computed in the original position in accordance with Heading (b) of this Subsection.

(2) Item 203(2), Drainage Excavation: Quantities will be in cubic yards (net section), computed in the original position in accordance with Heading (b) of this Subsection.

(3) Item 203(3), Muck Excavation: Quantities will be in cubic yards (net section), computed in the original position in accordance with Heading (b) of this Subsection. Reference is made to Subsection 203.04 for method of determination of elevations underwater.

(4) Item 203(4), Embankment in Place; and Item 203(5), Special Embankment (Nonplastic) in Place: Quantities will be in cubic yards (net section) computed in the final compacted position in accordance with Heading (b) of this Subsection.

(5) Item 203(6), Excavation and Embankment: The method of measurement will be as described under Heading (c) Linear Measurement, or Heading (d) Lump Sum Measurement, as specified.

(6) Item 203(7), Borrow: The method of measurement will be in accordance with Heading (e), Vehicular Measurement.

203.19 BASIS OF PAYMENT. The accepted quantities will be paid

for at the contract unit prices, which includes furnishing all equipment, labor and materials necessary to complete the work of the item, except where specific costs are designated or included in another pay item of work.

All incidental costs, such as acquisition of borrow materials outside the right-of-way, acquisition of right-of-way and constructing haul roads, stockpiling and rehandling of materials, precautionary measures to protect private property and utilities, and furnishing necessary water and watering equipment, shall be included in the unit price of the pay item.

When there is no pay item for furnishing and manipulation of lime, the cost thereof shall be included in the pay items that allow or require lime treatment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
203(1)	Unclassified Excavation	Cubic Yard
203(2)	Drainage Excavation	Cubic Yard
203(3)	Muck Excavation	Cubic Yard
203(4)	Embankment in Place	Cubic Yard
203(5)	Special Embankment (Nonplastic) in Place	Cubic Yard
203(6)	Excavation and Embankment	Station, Lump Sum
203(7)	Borrow (Vehicular Measurement)	Cubic Yard

No measurements will be made for excavation for culverts or culvert headwalls, except as provided below.

If the grade line of a pipe or box culvert is raised or lowered more than 2 feet from the grade line shown on the plans, or is relocated to a site requiring an equivalent change in excavation, payment will be increased or decreased accordingly at the rate of 3 times the contract unit price for Unclassified Excavation (or Embankment, if Unclassified Excavation is not a contract pay item).

The volume to be used in the payment adjustment will be a rectangular solid the length of the pipe or box culvert, the outside width of the pipe or box culvert plus 3 feet, and the average change in depth of invert elevation minus 2 feet.

Section 204

Temporary Erosion Control

204.01 DESCRIPTION. The work specified in this Section consists of measures required to control erosion on the project and in areas outside the right-of-way where work is accomplished in conjunction with the project, so as to prevent pollution of water, detrimental effects to public or private property adjacent to the project right-of-way and damage to work on the project. These measures shall consist of construction and maintenance of temporary erosion control features or, where practical, the construction and maintenance of permanent erosion control features as shown on the plans or as directed by the engineer.

The installation of temporary erosion control features shall be coordinated with the construction of the permanent erosion control features to the extent necessary to assure economical, effective and continuous control of erosion and water pollution throughout the life of the contract.

Due to unanticipated conditions, the engineer may direct the use of control features or methods other than those included in the original contract. In such event, this additional work will be paid for as extra work.

204.02 CONTROL OF CONTRACTOR'S OPERATIONS WHICH MAY RESULT IN WATER POLLUTION. The contractor shall take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, and other water impoundments, with fuels, oils, bitumens, or other harmful materials. Also, he shall conduct and schedule his operations so as to avoid or otherwise minimize pollution or siltation of such streams, etc., and to avoid interference with movement of migratory fish. No residue from dust collectors or washers shall be dumped into any live stream.

Construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other impoundments shall be restricted to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the plans and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, rivers, streams, and impoundments shall be promptly cleared of all obstructions placed therein or caused by construction operations.

When bridges are constructed over streams, the stream banks shall be kept in their natural state as much as possible. The contractor shall not unduly strip

existing protective vegetation in the vicinity of the stream banks and shall so conduct his operations as not to damage the banks with his equipment. No bank up or downstream shall be excavated except as provided for and as shown on the plans. No work roads shall be constructed upstream where it is necessary to cut the stream or river banks except by approval of the engineer. Banks cut for work roads shall be located downstream and replaced by the contractor to their original shape and density. Unnecessary stripping of vegetation along banks in the construction area will not be permitted.

Frequent fording of live streams with construction equipment will not be permitted.

Except as necessary for construction, excavated material shall not be deposited in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or runoff.

The contractor shall not disturb lands or waters outside the limits of construction, except as may be found necessary and authorized by the engineer.

The location of, and method of operation in, borrow pits, material pits, and disposal areas furnished by the contractor for waste material from the project (other than commercially operated sources) shall meet the approval of the engineer as being such that erosion during and after completion of the work will not result in probability of detrimental siltation or water pollution.

204.03 MATERIALS. The materials used for temporary erosion control shall conform to the following:

(a) Mulches—Wood chips obtained by grinding of trees cleared from the right-of-way or other approved mulches.

(b) Artificial Coverings—Fiber Glass Roving conforming to Section 720 or other approved materials.

(c) Temporary grass shall be a quick growing species suitable to the area providing a temporary cover which will not later compete with the grasses sown for permanent cover.

(d) Temporary slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, asphaltic concrete, plastic sheets, or other material acceptable to the engineer that will adequately control erosion.

(e) Fertilizer shall be a standard commercial grade acceptable to the engineer and meeting the quality requirements of Subsection 1017.16.

(f) Silt Fence Material—These materials shall consist of standard woven livestock wire, a minimum of 36 inches in height and a minimum of 14 gage wire with a maximum mesh spacing of 6 inches; posts shall be either wood or steel with a minimum length of 5 feet; and filter material shall be burlap weighing approximately 7½ ounces per yard or approved jute fabric or plastic filter cloth.

All materials that are not covered by the Standard Specifications or project specifications shall meet commercial grade standards and shall be approved by the engineer before being incorporated into the project. No testing of materials used in construction of temporary erosion control features will be required unless such material is to be incorporated into the completed project. Acceptance will be on the basis of visual inspection by the engineer.

204.04 PRECONSTRUCTION CONFERENCE. At the preconstruction conference or prior to the start of the applicable construction, the contractor shall present his proposed schedules for construction of the project in accordance with the requirements of this Section. The schedule shall be based on an analysis of project conditions and shall be in written form except for projects on which it is readily apparent that control of erosion is of a minor significance. This schedule shall specifically indicate the sequence of clearing and grubbing, earthwork operations and construction of permanent erosion control features, and the proposed use of temporary erosion control features. It shall also include proposed methods to prevent pollution of streams, lakes, tidal waters, reservoirs, canals, and other impoundments, as the result of construction operations. The contractor shall also outline his proposed methods of controlling erosion and preventing pollution on haul roads and in borrow pits, material pits, and areas used for disposal of waste materials from the project.

No work shall be started until the aforementioned schedules have been approved by the engineer; however, contract time charges will begin on the date stipulated in the Notice to Proceed. The contractor will be responsible for accomplishment of the work in accordance with the accepted plans and schedules. The engineer may approve changes made necessary by unforeseen conditions.

204.05 LIMITATION OF EXPOSURE OF ERODIBLE EARTH. The engineer may limit the surface areas of unprotected erodible earth exposed by clearing and grubbing, excavation or filling operations and may direct the contractor to provide immediate permanent or temporary erosion or pollution control measures to prevent contamination of any river, stream, lake, tidal waters, reservoir, canal, or other impoundment or to prevent detrimental effects on property outside the project right-of-way and damage to the project. The limitation of area in which excavation and filling operations may be underway shall be commensurate with the contractor's capability and progress in keeping the finish grading and permanent erosion control measures current in accordance with the accepted schedule.

204.06 INCORPORATION OF EROSION CONTROL FEATURES. Permanent erosion control features shall be incorporated into the project at the earliest practical time. Use of temporary erosion control features will be authorized to correct conditions that develop during construction which were not foreseen at the time of design, to control erosion prior to

the time it is practical to construct permanent control features, or to provide immediate temporary control of erosion that develops during normal construction operations but is not associated with permanent erosion control features on the project.

Temporary erosion control features may be authorized for use in controlling erosion in areas where stage construction or other conditions not under the control of the contractor, preclude completion of a section of roadway in a continuous manner and in areas where construction operations which must be performed subsequently, will cause damage to permanent erosion control features constructed.

204.07 SCHEDULING OF SUCCESSIVE OPERATIONS. The contractor shall schedule his operations such that the area of unprotected erodible earth exposed at any one time is not larger than the minimum area necessary for efficient construction operations, and the duration of exposed, uncompleted construction to the elements shall be as short as practicable.

Clearing and grubbing shall be so scheduled and performed that grading operations can follow immediately thereafter, and grading operations shall be so scheduled and performed that permanent erosion control features can follow as soon as practical.

204.08 DETAILS FOR TEMPORARY EROSION CONTROL FEATURES.

(a) General. Temporary erosion control features shall consist of, but not limited to, temporary grassing, temporary mulching, sandbagging, slope drains, sediment basins, sediment checkdams, erosion checks, artificial coverings and berms. The engineer may direct use of temporary erosion control features or methods other than those included in the original contract.

(b) Temporary Grassing. Seeding shall be done in accordance with the requirements of Section 717, except that ground preparation will be limited to blading the area to the amount deemed practical by the engineer for a seed bed and to eliminate water pockets. Lime and fertilizer may be omitted or the rate of application reduced as determined by the engineer. Mulch may be omitted or the application rate reduced as ordered.

(c) Temporary Mulching. This work shall consist of furnishing and applying a 2-inch to 4-inch thick blanket of straw or hay mulch to designated areas and then mixing or forcing the mulch into the top two inches of the soil in order to temporarily control erosion. Only undecayed straw or hay, which can readily be cut into the soil, shall be used. A ½-inch to 1-inch layer of wood chips may substitute for hay or straw. Wood chips need not be cut into the soil. Other means for temporary erosion control such as hydro-mulching, chemical adhesive soil stabilizers, etc., may be substituted for mulching with straw or hay if approved by the engineer.

When grassing operations begin, temporary mulch materials shall be plowed under in conjunction with preparation of the ground.

(d) Sandbagging. This work shall consist of furnishing and placing sandbags in configurations, so as to control erosion and siltation.

(e) Baled Hay. This work shall consist of furnishing and placing baled hay to form checks or dams to control erosion and siltation. Bales will be properly staked or otherwise secured as directed by the engineer.

(f) Slope Drains. This work shall consist of construction of slope drains with acceptable materials, in accordance with details shown on the plans or as may be approved by the engineer as suitable to adequately perform the intended function.

The discharge area shall be stablized or protected by temporary riprap as designated by the engineer. Cost will be included under the slope drains item.

(g) Sediment Basins. Sediment basins shall be constructed in accordance with the details shown in the plans or as may be approved by the engineer as suitable to adequately perform the intended function. Sediment basins shall be cleaned out as necessary in accordance with plan details or as directed by the engineer. The cost of the required clean-out operations will be included under the sediment basins item.

(h) Sediment Check Dams. This work shall consist of furnishing, constructing and maintaining erosion control check dams at locations shown on the plans or designated by the engineer in accordance with plan details. Check dams shall be constructed before any clearing and grubbing or grading in the affected area is begun unless otherwise directed by the engineer. Embankment material for earth dams shall be obtained from locations outside the affected area. The contractor shall maintain the dams in good condition throughout the life of the contract. All dams shall be removed prior to acceptance of the project unless the Department desires that they remain.

(i) Silt Fencing. This work shall consist of constructing silt fencing in accordance with the plans and these specifications at locations specified by the engineer. The contractor shall maintain the fencing in good condition as long as necessary.

(j) Artificial Coverings. This work shall consist of furnishing and applying jute matting, fiber glass roving or other approved coverings to the exposed surfaces as directed by the engineer.

(k) Berms. This work shall consist of construction of temporary earth berms to divert the flow of water from an erodible surface.

(l) Other Temporary Controls.

(1) Shown on the plans: When the need is evident during the design

stage, additional erosion control features will be shown on the plans together with appropriate notes covering materials and construction methods.

(2) Due to unforeseen conditions, the engineer may direct the contractor to construct such temporary devices as may be required to control erosion during construction. Details may be developed jointly by the engineer and the contractor. Payment for such other devices will be made at the unit prices bid for similar devices shown on the plans, or as extra work if plan details are not applicable.

(m) Removal of Temporary Erosion Control Features. In general, any temporary erosion control features existing at the time of construction of the permanent erosion control features in an area of the project shall be removed or incorporated into the soil in such manner that no detrimental effect will result. The engineer may direct that temporary features be left in place.

204.09 PROTECTION DURING SUSPENSION OF CONTRACT TIME. In the event that it is necessary that the construction operations be suspended for any appreciable length of time, the contractor shall shape the top of the earthwork in such manner as to permit runoff of rainwater and shall construct earth berms along the top edges of embankments to intercept runoff water. Temporary slope drains shall be provided to carry runoff from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes, and impoundments. Should such preventive measures fail, the contractor shall immediately take such other action as necessary to effectively prevent erosion and siltation. The engineer may direct the contractor to perform, during such suspensions of time, any other erosion control work deemed necessary.

204.10 METHOD OF MEASUREMENT. In the event that temporary erosion and pollution control measures are required due to the contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled or ordered by the engineer, such work shall be performed by the contractor at his own expense.

Temporary erosion and pollution control work required, which is not attributed to the contractor's negligence, carelessness or failure to install controls, will be performed as scheduled or ordered by the engineer. This complete and accepted work will be measured as follows:

(a) When separate items for temporary erosion control features are included in the contract, and the work is ordered by the engineer, the quantities to be paid under this Section shall be (1) the areas, in square yards, of Temporary Grassing, Temporary Mulching and Artificial Coverings complete in place; (2) the volume, in cubic yards, of Sandbagging with the measurement of sand being made in a batch box or by some other means satisfactory to the engineer; (3) the dry weight, in tons, of Hay Bales

actually used; (4) the length, in feet, of Temporary Slope Drains, measured along the surface of the work constructed and silt fencing, measured along ground surface between end posts; (5) the number of Sediment Basins and Sediment Check Dams acceptably constructed.

Items 204(3), Sandbagging (Temporary) and 204(4), Baled Hay (Temporary) will be paid for directly when used other than in the construction of Items 204(5), Slope Drains (Temporary), 204(6), Sediment Basins, and 204(7), Sediment Check Dams. When sandbags and baled hay are used in the construction of Items 204(5), 204(6) and 204(7), payment will be made under these items.

The temporary erosion control items may be eliminated when it is determined by the engineer that existing project conditions do not justify their use.

(b) When temporary erosion control work is ordered by the engineer and is not covered by existing contract items, the work shall be performed as extra work in accordance with Subsections 104.03 and 109.04 except that no extra work order will be required prior to starting work.

Erosion control work for the protection of construction areas outside the right-of-way, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the contractor, with costs included in the contract prices bid for the items to which they apply.

The construction of temporary earth berms along the edges of the roadway to prevent erosion during grading and subsequent operations will not be measured and paid for directly but will be included in the contract prices for earthwork items.

In case of repeated failures on the part of the contractor to control erosion, pollution or siltation, the engineer reserves the right to employ outside assistance or to use his own forces to provide the necessary corrective measures. Such incurred direct costs plus Project Engineering costs will be charged to the contractor and appropriate deductions made from the contractor's monthly progress estimate.

204.11 BASIS OF PAYMENT. Payment for temporary erosion control items that are required and included as contract items will be paid for at the contract unit price bid for the various items.

Temporary erosion control work not covered by contract items that is ordered by the engineer and is to be paid for directly will be paid for in accordance with Subsection 109.04.

Payment for designated temporary erosion control items will be made under:

Item No.	Pay Item	Pay Unit
204(1)	Mulching (Temporary)	Square Yard
204(2)	Grassing (Temporary)	Square Yard
204(3)	Sandbagging (Temporary)	Cubic Yard
204(4)	Baled Hay (Temporary)	Ton
204(5)	Slope Drains (Temporary)	Linear Feet
204(6)	Sediment Basins	Each
204(7)	Sediment Check Dams	Each
204(8)	Silt Fencing	Linear Feet

PART III

BASE AND SUBBASE COURSES

Section 301

Base Course

301.01 DESCRIPTION. This work consists of furnishing and placing a base course on a prepared surface in accordance with these specifications, in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer.

The plans or project specifications will usually indicate which base course types or classes the contractor may use.

A base course class is defined as a group of selected base course types that are required to meet the design requirements for a specific pavement structure.

If not specified or shown on the plans, the base course shall be composed of any of the types of material listed below (except multilayered base courses) at the option of the contractor.

Unless approved in writing by the engineer or specified in the plans or project specifications, the same type material shall be used throughout the project.

Types of Base Course:

Soil Cement
Cement Treated Sand Clay Gravel
Cement Treated Sand-Shell
Lime Treated Sand Clay Gravel
Sand Clay Gravel
Shell
Sand-Shell
Asphaltic Concrete
Multilayered

Multilayered base course shall consist of (1) one of the stabilized or treated base courses, or asphaltic concrete base course, and (2) sufficient material of the same type or, when specified, soil materials in accordance with Subsection 301.02 to provide the total thickness of base course shown on the plans.

With the approval of the engineer, Class R concrete conforming to Section 902 may be used in lieu of the specified base course material in areas that are inaccessible to mixing and compacting equipment, in turnouts and cross-

overs, and in other isolated or irregular areas. The concrete shall be placed, consolidated, finished and cured as directed.

301.02 MATERIALS. Materials shall conform to the following Subsections and these specific requirements.

Portland Cement	1001.02
Water	1017.01
Emulsified Asphalt	1002.03
Cutback Asphalt	1002.04
Sand Clay Gravel	1003.04(a)
Shell and Sand-Shell	1003.04(b)
Lime	1017.03

(a) Soil for Soil Cement: Soil for soil cement base course shall consist of selected materials that will stabilize with cement. Selected materials are those soils classified as A-1-a, A-1-b, A-2-4, A-2-6, A-3, A-4 and A-6 as classified under the test procedure DOTD Designation TR 423.

Soil with a liquid limit greater than 35, a plasticity index greater than 15, or an organic content greater than 5 percent shall not be used. Organic content will be determined in accordance with DOTD Designation: TR 413. Soil with silt content above 79 percent may be used if tested and approved prior to use.

The contractor shall obtain the material to be stabilized with cement from outside the right-of-way limits except as provided in Subsection 104.05.

(b) Soils for Multilayered Base Course: Unless otherwise specified, the soil layer for multilayered base course shall consist of embankment material in accordance with Section 203.

(c) Portland Cement and Lime: Portland cement may be Type I, IB or II. The quantity of these materials used shall be supported by invoices.

(d) Asphaltic Concrete Base Course: The material requirements for asphaltic concrete base course shall be as described in Section 501.

301.03 EQUIPMENT. Equipment necessary to produce a finished base course which meets specification requirements shall be furnished and maintained by the contractor.

When pugmills or mixing machines are used, they shall be approved by the engineer prior to use.

301.04 GENERAL CONSTRUCTION REQUIREMENTS. The asphaltic concrete base course shall be constructed in accordance with Section 501.

The soil layer for multilayered base course shall be constructed in accordance with Section 203.

Sterilization of shoulder base course material shall be in accordance with Subsection 301.13.

The base course materials shall be placed on a subgrade prepared in accordance with Section 203, or if specifically provided, in accordance with Section 302.

301.05 MIXING.

(a) Soil Cement: The soil materials shall be combined with portland cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture to within the tolerance specified herein shall be added and uniformly mixed with the materials. If prior to spreading the cement the moisture content of the soil is excessive, the soil shall be manipulated until the moisture content is such that the tolerance specified herein for the mixture can be met.

The percentage of cement will be determined in accordance with DOTD Designation: TR 432 prior to mixing. The method of mixing shall be such that the amount of cement used can be readily determined.

When central plant mixing is used, a reduction of 1 percent in the volume of cement required will be permitted.

The optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture, on the basis of dry weight, shall not vary from the specified optimum percentage of moisture by more than $\pm$ 2 percent at the time of compaction.

A minimum of 70 percent of the pulverized soil, as determined by DOTD Designation: TR 431, shall pass the No. 4 sieve after mixing.

(b) Cement Treated Sand Clay Gravel: The sand clay gravel materials shall be combined with portland cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture to within the tolerance specified herein shall be added and uniformly mixed with the materials. If prior to spreading the cement the moisture content of the material is excessive, the material shall be manipulated until the moisture content is such that the tolerance specified herein for the mixture can be met.

The percentage of cement required shall be 6 percent by volume, and the method of mixing shall be such that the amount of cement used can be readily determined. When central plant mixing is used, a reduction of ½ percent in the volume of cement required will be permitted.

The optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of

moisture in the mixture on the basis of dry weight shall not vary from the specified optimum percentage of moisture by more than ± 2 percent at the time of compaction.

(c) Cement Treated Sand-Shell: The sand-shell materials shall be combined with portland cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture to within the tolerance specified herein shall be added and uniformly mixed with the materials. If prior to spreading the cement the moisture content of the material is excessive, the material shall be manipulated until the moisture content is such that the tolerance specified herein for the mixture can be met.

The percentage of cement required for cement treated sand-shell will be 5 percent by volume. The method of mixing employed shall be such that the amount of cement used can be readily determined. When central plant mixing is used, a reduction of ½ percent in the volume of cement required will be permitted. The optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture on the basis of dry weight shall not vary from the specified optimum percentage of moisture by more than ± 2 percent at the time of compaction.

(d) Lime Treated Sand Clay Gravel: The sand clay gravel materials shall be combined with lime and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture to within the tolerance specified herein shall be added and uniformly mixed with the materials. If prior to spreading the lime the moisture content of the material is excessive the material shall be manipulated until the moisture content is such that the tolerance specified herein for the mixture can be met.

The percentage of lime required will be 10 percent by volume and the method of mixing shall be such that the amount of lime used can be readily determined.

The lime may be furnished in bags or bulk and distributed either in powder form or in a slurry in such manner as to assure obtaining the required proportions. The optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture on the basis of dry weight shall not vary from the specified optimum percentage of moisture by more than ± 2 percent at the time of compaction.

(e) Sand Clay Gravel: The sand clay gravel shall be uniformly mixed. If mixed prior to placement, it shall be mixed in an approved pugmill or on a mixing table. Materials shall be wet during mixing operations, if necessary, for proper blending.

Samples for acceptance testing will be taken after the materials have been thoroughly mixed.

(f) Shell or Sand-Shell Base Course: The base shall be uniformly mixed. If mixed prior to placement, it shall be mixed in an approved pugmill or on a mixing table. Materials shall be wet during mixing operations, if necessary, for proper blending. The sand and shell shall be tested and approved prior to mixing.

301.06 TRANSPORTING AND PLACING ON SUBGRADE. Transportation and spreading methods shall be such that minimum damage is done to the subgrade. It shall be the contractor's responsibility to place and spread sufficient material to obtain required width and compacted thickness within the tolerance set forth in Subsection 301.11. Every effort shall be made to prevent subgrade materials from contaminating the base course. Such contamination will require retesting and correction of deficiencies.

Base course materials shall not be placed, spread or mixed on portland cement concrete or asphaltic concrete pavements, and base course construction operations shall be conducted in such manner that pavement surfaces, edges and joints are not damaged.

301.07 COMPACTING AND FINISHING.

(a) Soil Cement: The mixture shall be uniformly compacted immediately upon completion of mixing or placement. The number and type of rollers used shall be sufficient to uniformly compact the base course to the specified depth and width, and within the specified time. Vibratory rollers will not be permitted in areas with high water tables. The surface shall be kept uniformly moist at all times during compaction and final finishing.

For soil containing 65 percent or more silt, classified as silty loams or silts, and having a plasticity index of 5 or less, compaction shall be by a sheepsfoot or similar type roller followed by a light pneumatic roller not exceeding 10 tons.

Compaction shall continue until the entire depth of each lift or the base course has met the requirements of Subsection 301.11.

At all places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain uniform compaction to required density without damage to adjacent structures.

All compaction shall be completed within 3 hours after initial mixing of cement with base course materials. Upon expiration of the 3-hour period after initial mixing, only blading of the base course surface will be allowed, and the bladed material shall not be drifted along the base but shall be wasted on the shoulders. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations, loose material or laitance.

(b) Cement Treated Sand Clay Gravel: Compaction and finishing requirements shall be the same as specified for soil cement.

(c) Cement Treated Sand-Shell: Compaction and finishing requirements shall be the same as specified for soil cement except that sheepsfoot or similar type rollers will be required for primary compaction.

(d) Lime Treated Sand Clay Gravel: Compaction and finishing requirements shall be the same as specified for soil cement except that the maximum period for completion of all compaction and finishing operations shall be 72 hours after initial mixing of lime with sand clay gravel. At the completion of the mixing operation, the surface shall be sealed to maintain moisture and section.

(e) Multilayered Base Course: Compaction and finishing requirements shall be as follows:

(1) The cement stabilized or treated layer shall conform to the requirements specified for soil cement.

(2) The remaining portion of the base course shall meet the requirements specified for untreated sand clay gravel, shell, sand-shell or lime treated sand clay gravel, or if the remaining portion is soil, the requirements of Section 203.

(f) Sand Clay Gravel: Following the placing, spreading and shaping of the base course material, it shall be brought to the moisture content required for compaction to the required density. Optimum moisture and maximum density will be determined in the Laboratory in accordance with DOTD Designation: TR 418. The density of the material in place on the roadway will be determined in accordance with DOTD Designation: TR 401. Any waves or irregularities that develop during rolling shall be corrected by scarifying and adding or removing material until the surface presents a smooth appearance. Between rollings, the surface shall be machined as necessary. Machining, watering and rolling shall continue until the full depth of base course has met the compaction requirements specified in Subsection 301.11. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, depressions or loose material.

(g) Shell or Sand-Shell Base Course: Compaction and finishing requirements shall be the same as for sand clay gravel. Sheepsfoot or similar type rollers will be required for primary compaction.

301.08 PROTECTION AND CURING.

(a) Soil Cement, Cement Treated Sand Clay Gravel, Cement Treated Sand-Shell, Lime Treated Sand Clay Gravel and Multilayered Base Course: Upon completion of smooth rolling of the final lift, the base shall be kept protected against rapid drying for a period of 72

hours by applying an approved asphaltic curing membrane consisting of either emulsified asphalt or cutback asphalt at the minimum rate of 0.10 gallon per square yard. Any additional applications required shall be placed by the contractor at his expense.

The asphaltic materials diluted with water or kerosene, as required, shall be applied so as to provide a continuous seal over the base course. The application shall be placed immediately following smooth rolling and shall be adequately maintained until the surfacing is applied.

All extraneous material which has collected on the completed base shall be removed before additional application of asphaltic curing membrane.

When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course during the 72-hour curing period, unless permitted by the engineer. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base course onto shoulders or other suitable areas during the 72-hour curing period whenever conditions permit.

If traffic is permitted to use the completed base course subsequent to the 72-hour curing period and/or prior to the construction of the surface course, the base shall be further protected by such additional applications of asphaltic curing membrane as required.

If the base course material consists of soil containing 65 percent silty loam or silt having a plasticity index of 5 or less, and if public traffic or construction traffic is permitted, the surfacing shall be constructed upon the base course immediately after the 72-hour curing period.

Prior to construction of the surface course the contractor shall clean the surface of base course, properly repair any damages caused by traffic and apply an additional application of asphaltic curing membrane (if necessary), all without additional compensation.

(b) Sand Clay Gravel, Shell and Sand-Shell Base Course: The completed base course will be opened to traffic when required by the project specifications or as directed. Any weak spots that develop shall be satisfactorily corrected and the base shall be kept free from irregularities. The base course shall be kept reasonably true to profile, grade and cross section. The base course shall not be allowed to become dusty with consequent loss of binder. The surface shall be kept moist, as directed, to avoid loosening of surface material. The base course shall be primed in accordance with Section 504.

301.09 MAINTENANCE. The contractor shall protect the completed base course from damage due to either public traffic or the contractor's operations, and shall maintain the completed base course in a satisfactory condition at all times, including any asphaltic curing membrane or prime coat. Any damaged base course shall be immediately repaired by the contractor at his

own expense. If patching of the base course is required, in addition to removing all damaged or unsound base course the contractor shall remove a sufficient width and depth of base course to insure satisfactory placement of the patching material. All patching or other repair of the base course shall be made in such manner as to restore a uniform surface and shall be completed at least 24 hours prior to surfacing or paving operations.

301.10 WEATHER LIMITATIONS.

Soil Cement, Cement Treated Sand Clay Gravel, Cement Treated Sand-Shell, Lime Treated Sand Clay Gravel and Multilayered Base Course: Mixing will not be permitted when the base course material or subgrade is frozen. Mixing shall be discontinued when a descending air temperature at the project site in the shade and away from artificial heat reaches 40°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

301.11 REQUIREMENTS AND TOLERANCES FOR ACCEPTANCE. The completed base course will be checked for determining acceptance as provided herein. The sampling schedule contained herein shall not prevent the project engineer from taking such additional tests as may be required for adequate control of the work in progress but such tests will be independent of the acceptance tests specified herein.

(a) Density Requirements: Upon completion of compaction operations, the density of the base course will be determined in accordance with DOTD Designation: TR 401. One density test will be taken per 1,000 linear feet per roadway. If any density test is below the requirements, 2 additional tests will be taken within 5 feet of the location of the failing test and the average of the 3 tests will be used as the value for the 1,000-foot section.

The density requirements as based on DOTD Designation: TR 418 shall be as follows:

Base Course Type	DOTD Designation	Compaction Min.
Soil Cement	TR 418 (B)	95%
Cement Treated Sand Clay Gravel	TR 418 (F)	95%
Cement Treated Sand-Shell	TR 418 (D)	95%
Lime Treated Sand Clay Gravel	TR 418 (F)	100%
Multilayered	See Note	
Sand Clay Gravel	TR 418 (E)	100%
Shell or Sand-Shell	TR 418 (C)	100%
Soil for Multilayered	TR 418 (A)	95%
Asphaltic Concrete	See Note	

NOTE: Multilayered base courses (except soils) shall meet the density requirements given in the preceding table for the top or the predominant

layer. The bottom layer shall be compacted to such a density that the requirements of the top layer can be met. When soil is used as a layer of multilayered base courses, the compaction requirements shall be as given in the preceding table.

The density requirements for asphaltic concrete base course shall be in accordance with Section 501.

(1) Soil Cement, Cement Treated Sand Clay Gravel, Cement Treated Sand-Shell and that Portion of Multilayered Bases Using One of These Types: If a test representing 1,000 linear feet of roadway does not meet the required 95 percent compaction, but is not below 93 percent, this section is acceptable provided the average of this test, the 2 tests of the 2 preceding sections and the 2 tests of the 2 succeeding sections meet the 95 percent requirement. In computing this average percent compaction of the five sections, any final test value in excess of 100 percent compaction will be considered as 100 percent.

If the average percent of compaction does not meet the 95 percent requirement, but is not below 93 percent and no final test value used to compute the average is below 90 percent, this section may remain in place at a penalty of 25 percent reduction in the contract unit price for the quantity involved.

If the average percent is below 93 percent but not below 90 percent and no final test value used to compute the average is below 90 percent, this section may remain in place at a penalty of 50 percent reduction in the contract unit price for the quantity involved.

Any section not meeting these tolerances, or is less than 90 percent, shall be reconstructed in accordance with these specifications at the contractor's expense.

(2) Lime Treated Sand Clay Gravel, Sand Clay Gravel, Shell, Sand-Shell Base and Soil for Multilayered Base Course: If any test value is less than that required in the preceding table, compaction will continue until the specified density is obtained.

(b) Thickness Requirements: The thickness of the completed base course shall be determined in accordance with DOTD Designation: TR 602.

No individual test of base course thickness shall vary from plan thickness in excess of the tolerances specified herein under Heading (1), nor shall the average of the individual thickness tests in any 3,000-foot section of base course vary in excess of the tolerances specified herein under Heading (2). Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at the contractor's expense.

(1) Thickness Tolerances for Individual Tests:

(All Base Courses) Underthickness	(Stabilized & Treated Base Course) Overthickness
¾ inch	1½ inches

Whenever an individual test is found to exceed the allowable tolerances, 2 additional tests shall be taken within 5 feet of the location of the failing test and the average of the 3 tests (rounded off to the nearest ¼ inch) will be used as the value for that location.

Sand Clay Gravel, Shell and Sand-Shell Base Course: Overthickness will be waived at no additional cost to the Department. Underthickness in excess of ¾ inch shall be corrected to plan thickness by furnishing, placing, shaping and compacting additional base course material as required.

Stabilized, Treated and Asphaltic Concrete Base Course: Overthickness of asphaltic concrete and pugmill-mixed stabilized or treated base course will be waived at no additional cost to the Department. If no grade adjustments are permitted by the engineer, all other thickness deficiencies shall be corrected by removing and replacing the full depth of base course in the deficient areas with one of the following materials:

a. The same type of base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

If grade adjustments are permitted by the engineer, the contractor shall have the option of correcting the thickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete conforming to Section 501 in lieu of removing and replacing the deficient base course. The thickness of the supplemental layer of asphaltic concrete shall be as follows:

Underthickness (Inches)	Overthickness (Inches)	Minimum Thickness of Supplemental Asphaltic Concrete (Inches)
1 to 1¼	1¾ to 2	1
1½ to 1¾	2¼ to 2½	1½
2 to 2½	2¾ to 3	2
Over 2½	Over 3	Remove & Replace

(2) Average Thickness Tolerances for 3,000-Foot Section: The average thickness of the completed base course in any 3,000-foot section shall not vary in excess of ½ inch from the plan thickness. The thickness value for the 3,000-foot section will be the computed average

of the individual tests taken in accordance with the requirements under Heading (1). In computing the average thickness of the 3,000-foot section, previously deficient areas which have been corrected by the placement of a supplemental layer of asphaltic concrete as specified under Heading (1) will be considered as being at plan thickness.

Sand Clay Gravel, Shell and Sand-Shell Base Course: Overthickness will be waived at no additional cost to the Department. In computing the average thickness of the 3,000-foot section, any overthickness in excess of plan thickness will be considered as being at plan thickness. Sections with an average underthickness in excess of ½ inch shall be corrected to plan thickness by furnishing, placing, shaping and compacting additional base course material as required; or at the contractor's option, the deficient section will be permitted to remain in place at an adjusted payment of 75 percent of the contract unit price.

Stabilized, Treated and Asphaltic Concrete Base Course: Overthickness of asphaltic concrete and pugmill-mixed stabilized or treated base course will be waived at no additional cost to the Department. In computing the average thickness of the 3,000-foot section, overthickness in excess of 1 inch will be considered as being 1 inch overthickness.

If no grade adjustments are permitted by the engineer, sections with average thickness deficiencies in excess of ½ inch shall be removed and replaced as specified for these type base courses in Heading (1); or at the contractor's option, the deficient section will be permitted to remain in place at an adjusted payment of 75 percent of the contract unit price for underthickness, and 90 percent of the contract unit price for overthickness.

If grade adjustments are permitted by the engineer, the contractor shall have the additional option of correcting sections with average thickness deficiencies in excess of ½ inch by furnishing and placing a 1 inch thick supplemental layer of asphaltic concrete conforming to Section 501. This supplemental layer of asphaltic concrete will not be required for those areas within the 3,000-foot section that were previously corrected with supplemental asphaltic concrete in accordance with the requirements under Heading (1).

(c) **Width Requirements:** The width of the completed base course will be determined in accordance with DOTD Designation: TR 602. Width of the roadway base course shall not vary from plan width in excess of 6 inches. Shoulder base course width shall not vary from plan width in excess of 3 inches. Base course width deficiencies in excess of the foregoing tolerances shall be corrected as follows at the contractor's expense.

Sand Clay Gravel, Shell, and Sand-Shell Base Course: Overwidths will be waived at no additional cost to the Department. Underwidths in excess of the foregoing tolerances shall be corrected to plan widths by

furnishing, placing, shaping and compacting additional base course material as required.

Stabilized, Treated and Asphaltic Concrete Base Course:

(1) Overwidth: Overwidths of asphaltic concrete and pugmill-mixed stabilized or treated base course will be waived at no additional cost to the Department.

If no grade adjustment is permitted by the engineer, the full depth and width of base course in isolated areas having overwidths in excess of the foregoing tolerances shall be removed and replaced to the plan width with one of the following materials:

a. The same type of base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

In lieu of removing and replacing the deficient areas of base course, at the contractor's option the deficient base course will be allowed to remain in place at an adjusted payment of 90 percent of the contract unit price for the 1,000-foot section.

If grade adjustments are permitted by the engineer, the contractor shall have the additional option of correcting base course width deficiencies by furnishing and placing a 1 inch thick supplemental layer of asphaltic concrete conforming to Section 501 on the 1,000-foot section.

(2) Underwidth: Underwidths of base course in excess of the foregoing tolerances shall be corrected to plan width by furnishing and placing additional materials; however, the width of the widening materials shall be not less than 12 inches. Materials used for widening the deficient base course shall be one of the following:

a. The same type of base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

(d) Dimensional Tolerances of Multilayered Base Course: The combined depth and width of the two components shall meet the thickness and width requirements of aggregate base courses (nonstabilized or untreated). The asphaltic concrete, stabilized or treated portion of this base course shall meet the width and depth requirements specified for these type base courses, including the average minimum thickness requirements. Any price adjustment applied to multilayered base course construction shall be applied to the entire depth of the base course for the deficient section.

301.12 SHOULDER CONSTRUCTION WITH BASE COURSE. When specified on the plans, aggregate and soil materials required on the shoulders in conjunction with base course shall be constructed to the depths shown on the plans and shall meet the requirements of Sections 203 and 401.

Payment will be made under Section 301, if specified on the plans.

301.13 SHOULDER BASE COURSE STERILIZATION. When specified on the plans, all shoulder base course material, except asphaltic concrete, shall be chemically sterilized.

(a) Materials: Materials shall be one of the sterilants on the Qualified Products List maintained by the Department's Materials Section or a sterilant that is approved for such listing prior to use.

(b) Equipment: Sterilant shall be applied with approved calibrated equipment with either mechanical or bypass agitation of the sterilant solution in the tank. If bypass agitation is used, the pump shall have 20 gpm minimum capacity. At least 70 percent of the pump's maximum capacity at 40 psi shall be returned to the tank.

(c) Application: Sterilant shall be applied to shoulder base course material after completion of compaction operations and prior to application of asphaltic curing membrane or prime coat. The sterilant shall be uniformly sprayed on the compacted base course surface at the required rate.

301.14 METHOD OF MEASUREMENT. The quantities of base course and shoulder base course sterilization for payment will be the design volumes or areas as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and compacted thickness of the completed base course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

301.15 BASIS OF PAYMENT.

(a) Base Course: The accepted quantity of base course will be paid for at the contract unit price, adjusted as specified in Subsection 301.11 and the following provisions, which includes furnishing and placing all required base course materials, portland cement, lime, water, asphaltic curing membrane and prime coat as required.

Price adjustments will be applied for specification deviations of the asphaltic materials used as specified in the appropriate schedules in Section 1002.

Asphaltic concrete base course will be further subject to price adjustments for deficiencies in Marshall stability, roadway density or aggregate graduation as specified in the appropriate schedules in Section 501. Only one price adjustment will be made for these deficiencies, and the schedule requiring the greatest reduction in contract unit price will be used for the price adjustment.

(b) Sterilization: If the contract includes a pay item for shoulder base course sterilization, the accepted quantity will be paid for at the contract unit price per square yard. If no pay item is included in the contract for

shoulder base course sterilization, the sterilization will be considered as incidental to the shoulder base course.

Payment will be made under:

Item No.	Pay Item	Pay Unit
301(1)	Base Course	Cubic Yard, Square Yard
301(2)	Sterilization of Shoulder Base Course	Square Yard

Section 302

Scarifying and Compacting Roadbed

302.01 DESCRIPTION. This work consists of scarifying, shaping and compacting an existing roadbed to form a subbase or base in accordance with these specifications, and in reasonably close conformity with the lines, grades, depth and cross section shown on the plans or established by the engineer.

302.02 CONSTRUCTION REQUIREMENTS. The existing roadbed materials shall be scarified for the full width of roadbed and a minimum depth of 6 inches, shaped to the required section, and uniformly compacted to at least 95 percent of maximum density for subbase, and 100 percent for base, as determined by DOTD Designations: TR 401 and TR 418. The scarified, shaped and compacted roadbed shall have a smooth, uniform, closely knit surface, free from ridges, waves, depressions or loose material.

302.03 CONSTRUCTION LIMITATIONS. The work of scarifying roadbed shall not be performed in excess of one mile in advance of compacting the roadbed, unless otherwise permitted by the engineer.

302.04 METHOD OF MEASUREMENT. The quantities of scarifying and compacting roadbed for payment will be the design lengths as specified in the plans and adjustments thereto. Design quantities are based on the horizonal length of the roadbed shown on the plans. Design quantities will be adjusted if the enginner makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

302.05 BASIS OF PAYMENT. The accepted quantity of scarifying and compacting roadbed will be paid for at the contract unit price per mile.

Payment will be made under:

Item No.	Pay Item	Pay Unit
302(1)	Scarifying and Compacting Roadbed	Mile

Section 303

In-Place Cement Stabilized Base Course

303.01 DESCRIPTION. This work consists of scarifying, pulverizing, blending, shaping and stabilizing existing roadbed material with portland cement in accordance with these specifications, in reasonably close conformity with the lines, grades, thickness and sections shown on the plans or established by the engineer.

This cement stabilization shall be primarily for existing roadbed materials; however, it shall include all materials furnished and placed on the roadbed under other pay items for the purpose of developing the required section in areas designated by the engineer or indicated in the plans or project specifications.

For bid purposes, the estimated rate of portland cement required for stabilization is 10 percent by volume; however, the actual rate of portland cement to be used for stabilization will be determined by the Laboratory. If the actual rate of cement differs from the estimated rate, the Department will make an adjustment for this difference, as specified in Subsection 303.12.

With the approval of the engineer, Class R concrete conforming to Section 902 may be used in lieu of the specified base course material in areas that are inaccessible to mixing and compacting equipment, in turnouts and crossovers, and in other isolated or irregular areas. The concrete shall be placed, consolidated, finished and cured as directed. The contractor shall, at his own expense, remove and satisfactorily dispose of existing materials as required to accomodate placement of the Class R concrete.

303.02 MATERIALS. Materials shall conform to the following Subsections.

Portland Cement	1001.02
Water	1017.01
Emulsified Asphalt	1002.03
Cutback Asphalt	1002.04

303.03 EQUIPMENT. Equipment necessary to produce a finished base course which meets specification requirements shall be furnished and maintained by the contractor.

Mixing machines shall be approved by the engineer prior to use.

303.04 PREPARATION OF ROADBED. The contractor shall scarify and pulverize the materials to be stabilized for the full width and depth of the cement stabilized base course. If the existing roadway has asphaltic surfacing the surfacing shall be pulverized and uniformly mixed with the materials below the surfacing.

Any surfacing materials or base materials which cannot be pulverized to the satisfaction of the engineer shall be removed from the roadway and disposed of as directed by the engineer, all at no cost to the Department.

Test samples will be taken after the materials have been thoroughly pulverized and blended. Materials failing to meet specifications shall not be stabilized until the necessary corrective measures have been taken to assure compliance.

After the roadbed has been prepared as specified above, the contractor shall shape the roadbed to the required section and uniformly compact the roadbed material to the satisfaction of the engineer.

Shoulder base course shall be chemically sterilized in accordance with Subsection 301.13.

303.05 MIXING. After the roadbed material to be stabilized has been prepared, portland cement shall be uniformly spread and mixed with the material and shaped to the required section.

Prior to mixing, the percent of cement to be used for stabilization will be determined by the Laboratory in accordance with DOTD Designation: TR 432 and the method of mixing shall be such that the amount of cement used can be readily determined.

Water shall be added as needed by means of the mixer and shall be uniformly incorporated in the mixture in the amounts required to attain the optimum moisture content specified for the mixture.

The optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture on the basis of dry weight shall not vary from the specified optimum percentage of moisture by more than ± 2 percent at the time of compaction.

303.06 COMPACTING AND FINISHING. The mixture shall be uniformly compacted immediately upon completion of mixing or placement. The number and type of rollers used shall be sufficient to uniformly compact the base course to the specified depth and width, and within the specified time. The surface shall be kept uniformly moist at all times during compaction and final finishing. Compaction shall continue until the entire depth of each lift of the base course has met the requirements of Subsection 303.10.

At all places inaccessible to rollers, such as edges adjacent to curb and

gutter sections, the mixture shall be compacted to the required density using devices that will obtain uniform compaction to required density without damage to adjacent structures.

All compaction shall be completed within 3 hours after initial mixing of cement with base course materials. Upon expiration of the 3 hour period after initial mixing, only blading of the base course surface will be allowed, and bladed material shall not be drifted along the base but shall be wasted on the adjacent shoulders or slopes. The finished base course shall have a smooth, uniform closely knit surface, free from ridges, waves, laminations, loose materials or laitance.

303.07 PROTECTION AND CURING. Upon completion of smooth rolling of the final lift, the base shall be kept protected against rapid drying for a period of 72 hours by applying an approved asphaltic curing membrane consisting of either emulsified asphalt or cutback asphalt at the minimum rate of 0.10 gallon per square yard.

The asphaltic materials diluted with water or kerosene, as required, shall be applied so as to provide a continuous seal over the base. The application shall be placed immediately following smooth rolling and shall be adequately maintained until the surfacing is applied. When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course during the 72-hour curing period, unless permitted by the engineer. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base course onto shoulders or other suitable areas during the 72-hour curing period whenever conditions permit.

If traffic is permitted to use the completed base subsequent to the 72-hour curing period and prior to the construction of the surface course, the base shall be further protected by such additional applications of the asphaltic curing membrane as required.

Prior to construction of the surface course the contractor shall clean the surface of base course, properly repair any damages caused by traffic and apply an additional application of asphaltic curing membrane (if necessary), all without additional compensation.

303.08 MAINTENANCE. The contractor shall protect the completed base course from damage due to either public traffic or the contractor's operations, and shall maintain the completed base course in a satisfactory condition at all times, including any asphaltic curing membrane or prime coat. Any damaged base course shall be immediately repaired by the contractor at his own expense. If patching of the base course is required, in addition to removing all damaged or unsound base course the contractor shall remove a sufficient width and depth of base course to insure satisfactory placement of the patching material. All patching or other repair of the base course shall be made in such manner as to restore a uniform surface and shall be completed at

least 24 hours prior to surfacing or paving operations.

303.09 WEATHER LIMITATIONS. Mixing will not be permitted when the base course material or subgrade is frozen. Mixing shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F, and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

303.10 REQUIREMENTS AND TOLERANCES FOR ACCEPTANCE. The completed base course will be checked for determining acceptance as provided herein. The sampling schedule contained herein shall not prevent the engineer from taking such additional tests as may be required for adequate control of the work in progress but such tests will be independent of the acceptance tests specified herein.

(a) Density Requirements: Upon completion of compaction operations, the density of the completed base course will be determined in accordance with DOTD Designation: TR 401. A minimum of one density test will be taken per 1,000 linear feet per roadway. If any density test is below the requirements, 2 additional tests will be taken within 5 feet of the location of the failing test and the average of the 3 tests will be used as the value for the 1,000-foot section.

The density requirements as based on DOTD Designation: TR 418 will be 95 percent of maximum density.

If a test representing 1,000 linear feet of roadway does not meet the required 95 percent compaction, but is not below 93 percent, this section is acceptable provided the average of this test, the 2 tests of the 2 preceding sections and the 2 tests of the 2 succeeding sections meet the 95 percent requirement. In computing this average percent compaction, any test value in excess of 100 percent compaction will be considered as 100 percent.

If the average percent of compaction does not meet the 95 percent requirement, but is not below 93 percent and no test value used to compute the average is below 90 percent, this section may remain in place at a penalty of 25 percent reduction in the contract unit price for the quantity involved.

If the average percent compaction is below 93 percent, but not below 90 percent and no test value used to compute the average is below 90 percent, this section may remain in place at a penalty of 50 percent reduction in the contract unit price for the quantity involved.

Any section not meeting these tolerances, or that is below 90 percent, shall be reconstructed in accordance with these specifications at the contractor's expense.

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD Designation: TR 602.

No individual test of base course thickness shall vary from plan thickness in excess of the tolerances specified herein under Heading (1) nor shall the average of the individual thickness tests in any 3,000-foot section of base course vary in excess of the tolerances specified herein under Heading (2). Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at the contractor's expense.

(1) Thickness Tolerances for Individual Tests:

Underthickness	Overthickness
¾ inch	1½ inches

Whenever an individual test is found to exceed the allowable tolerances, 2 additional tests shall be taken within 5 feet of the location of the failing test and the average of the 3 tests (rounded off to the nearest ¼ inch) will be used as the value for that locaton. Base course thickness deficiencies in excess of the foregoing tolerances shall be corrected as follows. If no grade adjustments are permitted by the engineer, thickness deficiencies shall be corrected by removing and replacing the full depth of base course in the deficient areas with one of the following materials:

a. Cement stabilized base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

If grade adjustments are permitted by the engineer, the contractor shall have the option of correcting the thickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete conforming to Section 501 in lieu of removing and replacing the deficient base course. The thickness of the supplemental layer of asphaltic concrete shall be as follows:

Underthickness (Inches)	Overthickness (Inches)	Minimum Thickness of Supplemental Asphaltic Concrete (Inches)
1 to 1¼	1¾ to 2	1
1½ to 1¾	2¼ to 2½	1½
2 to 2½	2¾ to 3	2
Over 2½	Over 3	Remove & Replace

(2) Average Thickness Tolerances for 3,000-Foot Section: The average thickness of the completed base course in any 3,000-foot section shall not vary in excess of ½ inch from the plan thickness. The thickness value for the 3,000-foot section will be the computed average of the individual tests taken in accordance with the requirements under Heading (1). In computing the average thickness of the 3,000-foot sec-

tion, overthickness in excess of 1 inch will be considered as being 1 inch overthickness, and previously deficient areas which have been corrected by the placement of a supplemental layer of asphaltic concrete as specified under Heading (1) will be considered as being at plan thickness.

If no grade adjustments are permitted by the engineer, sections with average thickness deficiencies in excess of ½ inch shall be removed and replaced as specified in Heading (1); or at the contractor's option, the deficient section will be permitted to remain in place at an adjusted payment of 75 percent of the contract unit price for underthickness, and 90 percent of the contract unit price for overthickness.

If grade adjustments are permitted by the engineer, the contractor shall have the additional option of correcting sections with average thickness deficiencies in excess of ½ inch by furnishing and placing a 1 inch thick supplemental layer of asphaltic concrete conforming to Section 501. This supplemental layer of asphaltic concrete will not be required for those areas within the 3,000-foot section that were previously corrected with supplemental asphaltic concrete in accordance with the requirements under Heading (1).

(c) **Width Requirements:** The width of the completed base course will be determined in accordance with DOTD Designation: TR 602. Width of the roadway base course shall not vary from plan width in excess of 6 inches. Shoulder base course width shall not vary from plan width in excess of 3 inches. Base course width deficiencies in excess of foregoing tolerances shall be corrected as specified herein at the contractor's expense.

(1) **Overwidth:** If no grade adjustment is permitted by the engineer, the full depth and width of base course in isolated areas having overwidths in excess of the foregoing tolerances shall be removed and replaced to the plan width with one of the following materials:

a. Cement stabilized base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

In lieu of removing and replacing the deficient base course, at the contractor's option the deficient base course will be allowed to remain in place at an adjusted payment of 90 percent of the contract unit price for the 1,000-foot section.

If grade adjustments are permitted by the engineer, the contractor shall have the additional option of correcting base course width deficiencies by furnishing and placing a 1 inch thick supplemental layer of asphaltic concrete conforming to Section 501.

(2) **Underwidth:** Underwidths of base course in excess of the foregoing tolerances shall be corrected to plan width by furnishing and plac-

ing additional materials; however, the width of the widening materials shall be not less than 12 inches. Materials used for widening the deficient base course shall be the same as specified for overwidth correction in Heading (1).

303.11 METHOD OF MEASUREMENT. The quantities of in-place cement stabilized base course for payment will be the design areas as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions of the completed base course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

If the contract includes a pay item for shoulder base course sterilization, measurement of the sterilization will be made as specified in Subsection 301.14.

303.12 BASIS OF PAYMENT.

(a) Base Course: The accepted quantity of in-place cement stabilized base course will be paid for at the contract unit price, adjusted as specified in Subsection 303.10 and the following provisions, which includes furnishing all required portland cement, water and asphaltic curing membrane, and performing all necessary roadbed preparation and pulverization.

Price adjustments will be applied for specification deviations of the asphaltic materials used as specified in the appropriate schedules in Section 1002.

If the actual rate of cement required differs from the estimated rate of 10 percent by volume, payment will be increased or decreased for this difference at the rate of $2.25 per hundred pounds (cwt) of cement, regardless of whether the actual rate is greater than or less than the estimated rate.

(b) Sterilization: If the contract includes a pay item for shoulder base course sterilization, the accepted quantity will be paid for as specified in Subsection 301.15. If no pay item is included in the contract for shoulder base course sterilization, the sterilization will be considered as incidental to the cement stabilized shoulder base course.

Payment will be made under:

Item No.	Pay Item	Pay Unit
303(1)	In-Place Cement Stabilized Base Course	Square Yard

Section 304

Lime Treatment

304.01 DESCRIPTION. This work consists of constructing one or more courses of a mixture of lime and soil, or soil-aggregate, and water in accordance with these specifications, in reasonably close conformity with the lines, grades, thicknesses and sections shown on the plans or established by the engineer.

Lime treatment of existing or new material for use in the embankment, subbase or base will be designated as Type A, B, C, D, or E.

Table I gives a synopsis of the requirements for the types of treatment.

304.02 MATERIALS. Materials shall conform to the following Subsections.

Lime	1017.03
Water	1017.01
Emulsified Asphalt	1002.03
Cutback Asphalt	1002.04

304.03 EQUIPMENT. Equipment necessary to produce a finished product which meets specification requirements shall be furnished and maintained by the contractor.

304.04 GENERAL CONSTRUCTION REQUIREMENTS. The material shall be kept moist after the lime is applied. Water shall be added as needed during the mixing and remixing operations, during the curing period, and to keep the cured material moist until covered.

Lime shall not be applied at any time on a frozen foundation. Lime for Type A, B and C treatments shall not be applied when the descending air temperature in the shade and away from artificial heat reaches 40°F, and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

Type A Treatment: Two increments of lime shall be incorporated in the following sequence: spreading the first increment of lime, initial mixing, watering, sealing and mellowing for a minimum of 48 hours; spreading the second increment of the lime, final mixing, watering as necessary, compacting, finishing and maintaining. Material for Type A treatment will be

TABLE I
Lime Treatment

Type	Use	Requirements
A	Base or Subbase	1. Two applications of lime 2. 48-hour mellowing or aging period 3. Pulverization after 1st application 4. Density control 5. Minimum thickness and width 6. 72-hour cure after 2nd application
B	Subbase	1. One application of lime 2. 48-hour mellowing or aging period 3. Pulverization 4. Density control 5. Minimum thickness and width 6. 72-hour cure
C	Conditioning for Cement Treatment or Stabilization	1. One application of lime 2. 48-hour mellowing or aging period 3. Pulverization 4. Compact to engineer's satisfaction 5. Minimum thickness and width 6. No cure required
D	Working Table	1. One application of lime 2. Compact to engineer's satisfaction 3. Minimum thickness and width 4. No cure required
E	Conditioning and drying	1. One application of lime per embankment lift 2. Embankment construction requirements

tested in accordance with DOTD Designation: TR 433.

Type B Treatment: One increment of lime shall be incorporated in the following sequence: spreading the lime, initial mixing, watering, sealing and mellowing for a minimum of 48 hours; and final mixing, compacting, finishing and maintaining. Material to be used for Type B treatment will be tested in accordance with DOTD Designation: TR 433.

Type C Treatment: One increment of lime shall be incorporated in the following sequence: spreading the lime, initial mixing, watering, sealing and mellowing for a minimum of 48 hours; and final mixing, compacting and finishing to the satisfaction of the engineer. Material for Type C treatment will be tested in accordance with DOTD Designation: TR 416.

Type D Treatment: One increment of lime shall be spread and mixed with the materials to be treated, watered as required and compacted to the satisfaction of the engineer.

Type E Treatment: One increment of lime shall be spread and mixed with the materials to be treated.

304.05 SPREADING AND MIXING. The percentage of lime to be incorporated shall be as specified in the plans or project specifications. If not specified, the required percentage of lime will be determined by the Laboratory.

A unit weight of 35 lbs. per cubic foot will be used to compute the required rate of application of lime by weight, regardless of the actual unit weight of the lime used.

The lime may be furnished in bags or bulk and distributed, either in powder form or in a slurry, in such manner as to assure obtaining the required proportion. Dry lime shall be prevented from blowing by adding water or other suitable means.

The lime shall be uniformly spread and uniformly mixed with the soil to the width and depth shown on the plans, or as directed. Any procedure which results in excessive loss or displacement of the lime shall be immediately discontinued.

Lime shall be applied on such areas as can be properly processed during the same working day. Any lime that has been exposed to the open air for a period in excess of 6 hours and lime lost or damaged before incorporation due to rain, wind or other cause will be rejected, deducted from measured quantities and shall be replaced by the contractor at no additional cost to the Department.

(a) Types A and B Mixing: Following the 48-hour mellowing period, the mixture shall be kept moist and manipulated until the requirements of Subsection 304.06 have been met.

The first application of lime for Type A treatment shall be processed to line and grade and sealed. Following the 48-hour mellowing period, the second application of lime shall be spread and mixed as described herein for the first application.

(b) Type C Mixing: Following the 48-hour mellowing period, the lime treated mixture shall be thoroughly manipulated to the satisfaction of the engineer. The mixture shall meet the gradation requirements of Subsection 304.06 prior to subsequent stabilization or treatment with portland cement.

(c) Types D and E Mixing: Mixing shall be accomplished with ordinary embankment construction methods and equipment.

304.06 PULVERIZATION. For Type A, B and C treatment, the pulverized mixture, exclusive of gravel, stone or other aggregate material, when tested in accordance with DOTD Designation: TR 431, shall meet the follow-

ing gradation requirements:

U.S. Sieve	Percent Passing
3/4''	95
No. 4	50

Pulverization requirements for Type A treatment shall be met prior to the second application of lime.

304.07 COMPACTING AND FINISHING.

(a) Type A: After the second application of lime has been spread and mixed as described in Subsection 304.05, the mixture shall be uniformly compacted to at least 95 percent of maximum density as determined by DOTD Designations: TR 401 and TR 418. All compaction shall be completed within 6 hours after meeting pulverization requirements and/or the last application of lime.

One density test will be taken per 1,000 linear feet per roadway. If any density test is below 95 percent compaction, 2 additional tests will be taken within 5 feet of the location of the failing test and the average of the 3 tests will be used as the value for the 1,000-foot section. Any section not meeting the required 95 percent compaction shall be reconstructed in accordance with these specifications at the contractor's expense.

At all places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain uniform compaction to required density without damage to the adjacent structures.

The final finish shall have a smooth, uniform, closely knit surface, free from ridges, waves, loose material or laitance.

(b) Type B: Compacting and finishing of the Type B lime treated materials shall be as described for Type A treatment.

(c) Type C: Type C lime conditioned materials shall be shaped and uniformly compacted to the required sections.

(d) Type D: Type D lime treated materials shall be uniformly compacted and finished to the satisfaction of the engineer.

(e) Type E: Type E lime treated materials shall be compacted and finished in accordance with the normal embankment construction procedures of Section 203.

304.08 PROTECTION AND CURING (TYPES A AND B). The contractor shall have the option of using either of the following curing methods.

(a) Water Curing: After finishing operations have been completed, no vehicle or equipment other than sprinkling equipment shall be permitted on the lime treated material for a minimum of 72 hours, unless otherwise

directed. During the curing period, the lime treated material shall be lightly sprinkled with water at frequent intervals to prevent drying.

Any damage to the lime treated material due to the contractor's operations shall be repaired at no expense to the Department.

(b) Asphaltic Curing Membrane: After finishing operations have been completed, the material shall be kept protected against rapid drying for a period of 72 hours by applying an approved asphaltic curing membrane consisting of either emulsified asphalt or cutback asphalt at the minimum rate of 0.10 gallon per square yard.

The asphaltic materials diluted with water or kerosene, as required, shall be so applied as to provide a continuous seal. The application shall be placed immediately following smooth rolling and shall be adequately maintained during the 72-hour curing period.

When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course during the 72-hour curing period, unless permitted by the engineer. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base course onto shoulders or other suitable areas during the 72-hour curing period whenever conditions permit.

If traffic is permitted to use the completed surface subsequent to the 72-hour curing period the lime treated material shall be further protected by such additional applications of the curing membrane as the engineer may deem necessary and as specified above. Any damages thereto caused by traffic shall be properly corrected without additional compensation.

304.09 DIMENSIONAL TOLERANCES (TYPES A AND B TREATMENTS).

(a) General: The thickness and width of completed lime treated courses will be checked for determining acceptance in accordance with DOTD Designation: TR 602. The sampling schedule contained herein shall not prevent the engineer from taking such additional tests as may be required for adequate control of the work in progress, but such tests will be independent of the acceptance tests specified herein.

Areas not meeting the tolerances specified herein will be delineated and shall be corrected to plan dimensions by scarifying, remanipulating and recompacting the deficient areas at the contractor's expense.

(b) Thickness Requirements: Underthickness shall not exceed ¾ inch. Overthickness will be waived at no additional cost to the Department.

(c) Width Requirements: Underwidth shall not exceed 6 inches, except that underwidth on shoulders shall not exceed 3 inches. Overwidth will be waived at no additional cost to the Department.

304.10 METHOD OF MEASUREMENT.

(a) Lime: Lime used and accepted for treatments will be measured by the ton (2,000 pounds).

If lime is furnished in bags, the number of bags used and the weight per bag will be used for measurement.

When lime is furnished in bulk, the contractor shall furnish certified weights for each transport load or furnish certified scales on the project site so each transport delivered and used can be weighed.

(b) Treatment: The quantities of Type A, B, C and D lime treatment for payment will be the design areas as specified in the plans and adjustments thereto. Design quantities are based on the horizonal dimensions of the completed lime treatment shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

No measurement for payment will be made for Type E lime treatment other than measurement as specified above for the quantity of lime used and accepted in the Type E Treatment.

All costs for water used in lime treatment, and asphaltic curing materials, will be incidental to the lime treatment.

304.11 BASIS OF PAYMENT.

(a) Lime: The accepted quantities of lime for all types of lime treatments will be paid for at the contract unit price per ton.

(b) Treatment: The accepted quantities of Type A, B, C and D lime treatment will be paid for at the respective contract unit prices per square yard, adjusted as specified in the appropriate schedules of Section 1002 for specification deviations of the asphaltic materials used.

Payment will be made under:

Item No.	Pay Item	Pay Unit
304(1)	Lime	Ton
304(2)	Lime Treatment (Type A)	Square Yard
304(3)	Lime Treatment (Type B)	Square Yard
304(4)	Lime Treatment (Type C)	Square Yard
304(5)	Lime Treatment (Type D)	Square Yard
304(6)	Lime (Type E Treatment)	Ton

Section 305

Subbase Treatment

305.01 DESCRIPTION. This work consists of treating subbase materials with either lime or portland cement, as specified, in accordance with plan details and these specifications. Subbase materials to be treated shall be existing materials and/or materials furnished and placed under other pay items. The width and depth of the subbase treatment, and the required volumetric percentage of lime or cement for treatment, shall be as specified in the plans or project specifications.

305.02 MATERIALS. Materials shall conform to the following Subsections.

Lime	1017.03
Portland Cement	1001.02
Water	1017.01
Emulsified Asphalt	1002.03
Cutback Asphalt	1002.04

305.03 EQUIPMENT. Equipment necessary to produce a finished product which meets specification requirements shall be furnished and maintained by the contractor.

305.04 CONSTRUCTION REQUIREMENTS.

(a) Lime Treatment: Subbase treatment with lime shall be constructed in accordance with the requirements of Section 304 for Type B lime treatment.

(b) Cement Treatment: Subbase treatment with portland cement shall be constructed in accordance with the requirements of Section 303.

305.05 METHOD OF MEASUREMENT. The quantities of subbase treatment for payment will be the design areas as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions of the completed subbase treatment shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

All required lime, portland cement, water and asphaltic curing materials will be considered as incidental to the treatment, and will not be measured for separate payment.

305.06 BASIS OF PAYMENT. The accepted quantities of subbase treatment will be paid for at the contract unit price per square yard, adjusted as specified in Subsection 303.10 for deficiencies in density, thickness and width, and also adjusted as specified in the appropriate schedules of Section 1002 for specification deviations of the asphaltic materials used.

Payment will be made under:

Item No.	Pay Item	Pay Unit
305(1)	Subbase Treatment	Square Yard

PART IV

SURFACE COURSES

Section 401

Aggregate Surface Course

401.01 DESCRIPTION. This work consists of constructing an aggregate surface course for roadway, shoulders or driveway entrances in accordance with these specifications, and in reasonably close conformity with the lines, grades, thicknesses and typical sections shown on the plans or established by the engineer.

401.02 MATERIALS. Aggregate surface course shall, at the option of the contractor, be gravel with binder, crushed stone with binder, sand clay gravel or shell. Approximately 60 percent gravel or crushed stone shall be mixed with 40 percent binder.

Materials shall conform to the following Subsections.

Gravel	1003.05(a)
Crushed Stone	1003.05(b)
Binder	1003.05(c)
Sand Clay Gravel	1003.05(d)
Shell	1003.05(e)

401.03 EQUIPMENT. Equipment necessary to produce a finished product which meets specification requirements shall be furnished and maintained by the contractor.

401.04 SUBGRADE. The subgrade shall be prepared as provided in Section 203 and shall be approved before any surfacing material is placed. On existing shoulders, all vegetation shall be removed and the shoulders shall be shaped and compacted to the satisfaction of the engineer prior to placing aggregate surfacing. Material removed from shoulders shall be uniformly spread on adjacent slopes. Preparation of existing shoulders will be considered as incidental to the aggregate surfacing and no separate payment will be made therefor.

401.05 PLACING MATERIAL. The material shall be deposited directly on the subgrade from vehicles used for hauling or from spreading equipment. No surface course shall be placed on a muddy or rutted subgrade.

Aggregate surfacing materials shall not be placed or spread on portland cement concrete or asphaltic concrete pavements, and aggregate surfacing operations shall be conducted in such manner that pavement surfaces, edges

and joints are not damaged.

401.06 MIXING. Aggregate surfacing consisting of a combination of materials shall be uniformly mixed prior to placing on the subgrade. The mixed materials shall conform to the requirements specified in Subsection 401.02 prior to placement on the subgrade.

401.07 SHAPING AND COMPACTING. The material shall be shaped by suitable means while being compacted. Any ruts formed shall be filled by blading as often as necessary to prevent breaking through the surfacing material into the subgrade. Holes, waves and deficiencies in thickness which may develop and are not filled by blading shall be filled by adding more material. Shaping and compacting shall continue until the surface reasonably conforms to the cross sections shown on the plans and until it is free from ruts and waves.

The aggregate surfacing shall be compacted by a minimum of 12 passes of a 5,000-pound sheepsfoot roller with a single 3-foot to 4-foot diameter drum, or other approved method of compaction. Upon completion of the required number of passes with the compaction equipment, the surface will be wetted as necessary and rolled with a pneumatic-tire roller or steel wheel roller to insure a tight, uniform surface.

On shoulders less than 5 feet wide and ramps, the aggregate surfacing shall be wetted as necessary, shaped to the required section and uniformly compacted with suitable compaction equipment until a tight, uniform surface is obtained.

401.08 DIMENSIONAL TOLERANCES. When net section measurement is specified, the thickness and width of completed aggregate surface course will be checked for determining acceptance in accordance with DOTD Designation: TR 602. Areas with thickness and width deficiencies in excess of the following tolerances shall be corrected to plan dimensions by furnishing, placing, shaping and compacting additional materials as required at the contractor's expense.

(a) Thickness: Underthickness shall not exceed ¾ inch. Overthickness will be waived at no additional cost to the Department.

(b) Width: Underwidth on roadways shall not exceed 6 inches. Underwidth on shoulders shall not exceed 3 inches. Overwidth will be waived at no additional cost to the Department.

401.09 METHOD OF MEASUREMENT.

(a) Net Section: The quantities of aggregate surface course for payment will be the design volumes as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and the compacted thickness of the completed aggregate surface course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are

necessary.

(b) Vehicular Measurement: Aggregate surface course will be measured by the cubic yard in approved vehicles at the point of delivery in accordance with Subsection 109.01.

Water required for mixing and operations will be considered as incidental to the surface course.

401.10 BASIS OF PAYMENT. The accepted quantity of aggregate surface course will be paid for at the respective contract unit prices per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
401(1)	Aggregate Surface Course (Net Section)	Cubic Yard
401(2)	Aggregate Surface Course (Vehicular Measurement)	Cubic Yard

PART V

ASPHALTIC PAVEMENTS

Section 501

Asphaltic Concrete Mixtures

501.01 DESCRIPTION. These specifications are applicable to asphaltic concrete wearing, binder and base course mixtures of the plant mix type or a combination of these courses, each consisting of a mixture of mineral aggregate and asphalt cement with additives as required. The specifications for asphaltic concrete friction course mixtures are contained in Section 502.

This work consists of furnishing and constructing one or more courses of asphaltic concrete mixture applied hot to the prepared foundation in reasonably close conformance with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer, within tolerances specified. Work will be accepted on a lot basis as specified.

The contractor shall be responsible for the design, control, transportation and placing of the mixtures in accordance with these specifications.

The type of mixture furnished shall be as indicated on the plans or if more than one type is indicated, whichever type the contractor elects, but in any event shall be one of the following types:

(a) **Type 1 mix** shall be composed of the following:

(1) **Wearing Course:** Crushed gravel, crushed slag, crushed stone or a combination of these materials, sand, mineral filler and asphalt cement.

(2) **Binder Course:** Crushed gravel, crushed stone, crushed slag, crushed shell or a combination of these materials, sand, mineral filler and asphalt cement.

(b) **Type 2 mix** shall be composed of crushed clam shell, crushed reef shell or a combination thereof, sand, mineral filler (when needed) and asphalt cement.

(c) **Type 3 mix** shall be composed of the following:

(1) **Wearing Course:** Crushed gravel, crushed slag, crushed stone combined with crushed gravel, slag, stone or other approved types of screenings, sand, mineral filler and asphalt cement.

(2) **Binder Course:** Crushed gravel, crushed slag, crushed stone, crushed shell or a combination of these materials, sand, mineral filler, and asphalt cement.

(d) Type 4 mix shall be composed of expanded clay aggregate, sand, mineral filler and asphalt cement.

(e) Type 5 Mix — Base Course:

(1) Mix 5A shall be composed of gravel, slag, stone, reef shell, clam shell or expanded clay; sand; mineral filler (when needed); and asphalt cement.

(2) Mix 5B shall be composed of gravel, slag, stone, reef shell, clam shell or expanded clay; sand; and asphalt cement; or pit run sand clay gravel and asphalt cement.

(f) Shoulder mix shall be composed of crushed gravel, crushed slag, crushed stone, crushed shell, expanded clay or a combination of these materials; sand; mineral filler (when specified); and asphalt cement.

The thickness of courses shall be in approximate conformity with the plan typical sections unless otherwise specified. If the contract provides for both binder and wearing courses, the contractor will be permitted, at his option, to substitute wearing course material for binder course material at no change in unit price. Should the contractor elect to make such substitution, the mixture will be laid in layers of such thickness that the compaction and surface requirements are met. No substitutions are allowed for Types 3 and 5 mixtures without the written approval of the engineer. The mineral aggregate and asphalt cement shall be combined in such proportions that the mixture shall meet the following requirements by weight:

Mix	Asphalt Cement Percent	Aggregate Percent	Percent Crushed Ret. on #4	Percent Mineral Filler Minimum (1)
Type 1:				
WC	4.5 to 7.0	93.0 to 95.5	75 Min.	3
BC	3.8 to 7.0	93.0 to 96.2	60 Min.	2
Type 2:				
WC & BC	4.5 to 7.5	92.5 to 95.5		As Needed
Type 3:				
WC	4.5 to 7.0	93.0 to 95.5	80 Min.	2
BC	3.8 to 7.0	93.0 to 96.2	60 Min.	2
Type 4:				
WC & BC	6.0 to 8.5	91.5 to 94.0		2
Type 5:				
Base Courses				
(A)	3.5 to 8.5	91.5 to 96.5	As Needed	As Needed
(B)	3.5 to 8.5	91.5 to 96.5		
Shoulder Mix:				
WC	Any wearing course listed above			
Base	3.5 to 8.5	91.5 to 96.5		

(1) When hydrated lime is used as filler only ½ as much will be required. When crushed stone aggregate is used, mineral filler may be reduced or eliminated with prior approval from the engineer.

A description of the various mixtures is given in Table V of this Section.

501.02 MATERIALS. Materials shall conform to the following Subsections.

Asphalt Cement	1002.02
Aggregates	1003.07
Filler	1003.07(f)

501.03 ASPHALT CEMENT. Unless otherwise specified in the plans or project specifications the grade of asphalt required will be AC-40.

A silicone additive shall be dispersed in the asphalt cement by methods and in concentrations given in the Qualified Products List. The silicone additive material shall be approved by the Department prior to use.

An anti-stripping additive, added at the approximate rate of 0.5 percent by weight of the asphalt cement, shall be thoroughly mixed with the asphalt cement at the plant. The anti-stripping additive must be approved by the Department and listed on the Qualified Products List prior to use. The anti-stripping additive shall be dispersed by either (1) measuring into the transport or into the asphalt feed line between the transport and storage tank or (2) adding directly to storage tank and having total contents of tank circulated through pump one time prior to use. When crushed shell, crushed limestone or expanded clay is used as aggregate, anti-stripping additive will not be required.

501.04 DESIGN AND QUALITY CONTROL OF MIXTURES.

(a) General: The contractor shall assume full responsibility for the design and quality control of the mixtures. He shall design the mixture in accordance with the physical properties contained in Table V of this Section. He shall assume responsibility for the initial determination and all necessary subsequent adjustments in proportioning of materials used to produce the specified job mix and other physical characteristics.

The contractor will be required to have a Certified Asphaltic Concrete Technician present at all times when the plant is in operation. A Certified Asphaltic Concrete Technician is that person who is capable of designing the asphaltic concrete mixes at the plant. He will also be capable of conducting any test or analysis necessary to put the plant into operation and to produce a mixture within the requirements of the specifications. The certification will be awarded by the Department upon satisfactory completion of an examination.

(b) Job Mix Formula: No work shall be started nor any mixture accepted until the contractor has submitted, in writing for approval, his job

mix formula for the mixture he proposes to furnish. The formula so submitted shall indicate a single definite percentage of aggregate passing each required sieve size, a single percentage of asphalt cement, a single temperature at which the mixture is to be produced, the wet and dry mixing time when pugmill mixing is used, and the amount and types of additives to be used.

(c) **Approval of Job Mix Formula:** The contractor will be given 2 days operation at the start of the project in order to make any necessary adjustments or corrections in the proposed job mix formula and establish his construction procedures and sequences. A day's operation will be considered to be any day on which the plant is in operation for a period greater than 2 hours.

When storage bins are used, the mix stored will be considered as part of the lot for the day it is placed and compacted. In the event no other mix is produced and applied then it will be treated as a lot by itself.

The contractor will be given an additional adjustment period whenever a change in mixture type or course is required by the specifications or plans and a change in the proportions of the various components is required to accomplish this. When the contractor elects to substitute a wearing course mixture for binder course, he will be allowed a two day adjustment period for roadway density, however, he will not be allowed an adjustment period for any of the other acceptance properties upon starting wearing course operations. However, in cases where the mixture being produced is used for patching or other incidental work, an additional adjustment period will be allowed, even though the mix is not changed.

The material produced and placed during the period of adjustment time shall be paid for at 100 percent of the contract unit price, provided it (1) meets the minimum requirements for 80 percent payment given in Schedules 1 and 2 of Subsection 501.25; (2) meets minimum requirements for 100 percent payment given in Schedule 3 of Subsection 501.25. If it does not meet these requirements, it will be paid for as provided in the schedules. Adjustment in unit price for gradation given in Schedule 4 will not be applied during the adjustment period. If the job mix formula cannot be established during the adjustment period, all material produced after this period will be paid for in accordance with Subsection 501.25. Following the initial setup of the asphaltic concrete mix according to the contractor's submitted job mix formula, the plant shall operate at least 30 minutes prior to sampling of the mix by the engineer. Four trucks shall be sampled at random for determination of Marshall test properties as based on one briquette per sample. Only two of these samples shall be analyzed for asphalt content and extracted gradation.

It is recommended that the average of four Marshall stabilities, for approval of the job mix formula, conform to the design values given in Table

V of this Section. The contractor has the option of submitting a job mix formula that does not meet these values, provided the average of the four stability results meets the minimum requirements given in Table V.

Mixing shall be accomplished in a manner that will give a minimum coating of 95 percent of the coarse aggregate particles when tested in accordance with AASHTO Designation: T 195. The asphalt content and extracted gradation shall be within the tolerances applied to the job mix formula initially submitted by the contractor.

The engineer may permit the contractor to change the job mix formula provided the changed job mix meets all the physical requirements of the specifications. This change shall be made in writing along with adequate documentation of trial runs and results achieved.

Individual materials from more than one source shall not be used alternately nor mixed when used in surface courses without the written consent of the engineer. Where additional sources of materials are submitted to the engineer for approval as described in the preceding paragraph, a job mix formula shall be established and approved before the new material is used. When unsatisfactory results or other conditions make it necessary, the contractor may be required to establish a new job mix formula.

If a change in the job mix formula for the mixture being used is necessary, there will be no additional adjustment period and the mix produced during this period will be paid for in accordance with Subsection 501.25.

(d) Application of Job Mix Formula and Allowable Tolerances for Control of Mixes: The plant shall be operated so as to produce a mixture conforming to the approved job mix formula except that variations may occur within specified control limits for individual and average of two samples given in Table I.

In order to assure process control, the contractor shall obtain a minimum of two samples from each lot which is designated as one day's production of a given mixture. Each sample shall be obtained using random sampling techniques. One should represent the first half and the other the second half of the working day.

It is suggested that the contractor use the results of individual tests for plant control. When individual test results indicate a tendency for the mix to fall outside of control limits, the contractor should make adjustments to bring the mix into the job mix formula.

501.05 PLANT EQUIPMENT. Asphaltic concrete shall be mixed at a central mixing plant by either batch, continuous or dryer-drum mixing process at the option of the contractor. The aggregates and asphalt may be proportioned either by weight or volume. All plants used shall conform to the requirements given in the succeeding paragraphs.

TABLE I

U. S. SIEVE	Control Limits	
	Individual	Average of 2 Tests
¾ inch and larger	±9	±6
½ inch	±12	±9
⅜ inch	±10	±7
No. 4	±10	±7
No. 10	±9	±6
No. 40	±7	±5
No. 80	±5	±4
No. 200	±3	±2
Percent Asphalt	±.6	±.4
Temperature of Mix °F*	±25	±25
Percent Crushed	Minimum Value as specified in Table V of this Section.	

* As based on approved mixing temperature after discharge into the truck.

NOTE: When control limits as specified exceed the upper or lower limits for allowable gradations contained in Table V of this Section, the control limits are fixed at the same values as those required by the specification limits.

The plant used shall be so designed and operated as to produce a mixture within the requirements of these specifications.

The contractor is required to have a plant site laboratory meeting the minimum requirements of Subsection 722.04 as a part of his plant facilities.

The Department reserves the right to require the contractor to change from the dryer-drum process or screenless operation to conventional batch or continuous plants with screens if it is determined that the equipment or the materials furnished will not produce a satisfactory mixture meeting all specification requirements.

(a) **General Requirements:** The following requirements apply to all types of plants unless otherwise specified:

(1) **Asphalt Preparation Equipment:** The asphalt working tank shall be capable of uniformly heating the material, under positive control, to the required temperature. Heating shall be accomplished by ap-

proved means. The circulating system for asphalt cement shall be of adequate size to insure proper and continuous circulation during the entire operating period. All pipelines and fittings shall be heated or insulated. Tank capacity shall be sufficient for satisfactory plant operation. In addition to working tanks the contractor shall provide adequate storage tanks for asphalt.

(2) **Cold Aggregate Feeder:** The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the dryer. The feeders shall be capable of delivering the maximum number of aggregate sizes required in their proper proportion. When more than one cold feeder is used, each shall operate as a separate unit, and the individual controls shall be integrated with a total master control.

In cases where the contractor elects to use either a dryer-drum process or screenless plant operation, the cold feed system will be such that it will control proportioning of aggregates accurate enough to produce a gradation consistently within the job mix formula. An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty or flow is interrupted.

(3) **Dryer:** The plant shall include one or more dryers that will continuously agitate the aggregates during the heating and drying process. The equipment shall be capable of heating and drying all aggregates specified in the necessary quantities to supply the mixing unit continuously at its operating capacity and at a specified temperature and acceptable moisture content.

(4) **Thermometers:** A thermometer shall be fixed in the asphalt feed line at an approved location near the discharge valve at the mixer unit except in dryer-drum plants where a recording thermometer shall be located to indicate the temperature of the asphalt cement in storage. The plant shall also be equipped with an approved recording thermometer having an accuracy of ± 5°F and a sensitivity which will provide an indication of temperature change at the rate of not less than 10°F per minute. It shall be placed at the discharge chute of the dryer to register automatically the temperature of the heated material. The immediate repair or replacement of any defective or unsatisfactory instrument by some approved temperature recording apparatus will be required.

(5) **Dust Collector:** The plant shall be provided with a dust collection system meeting all federal, state and local requirements.

(6) **Asphalt Measuring Equipment:** Asphalt may be introduced either by weighing or volumetric measurement. When scales are used, they shall conform to Heading (b)(4) of this subsection and shall read to the nearest pound. In cases where the asphalt is measured by volumetric means, provisions shall be made to periodically check the quantity of asphalt delivered by weight and the quantity and the rate of asphalt de-

livered will be continuously displayed in digital form.

All asphalt measuring, regardless of the method used, shall be accurate to one percent of the quantity measured. For continuous and batch plants, the asphalt shall be sprayed in a manner which gives the most rapid and complete coating.

(7) **Mixer Unit:** For batch and continuous methods of operation, the plant shall have an approved pugmill capable of producing a uniform mixture within the specified tolerances. For batch plants, the pugmill will be inspected by the engineer to determine its capacity. For continuous plants, the paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on the permanent gage.

(8) **For continuous and dryer-drum plants** and when storage or surge bins are used with all other type plants, the contractor will furnish truck-platform scales for the purpose of determining the pay weights for the mix. The scales shall be of sufficient length to weigh the entire unit transporting the mix and shall be the product of a reputable manufacturer and of a simple rugged design with the minimum number of adjustments consistent with the accuracy required, all as approved by the engineer. The scales shall be accurate to 0.5 percent of the loads applied. The contractor shall have the scales certified by the Weights and Measures Division of the Louisiana Department of Agriculture, or by a qualified independent scale service, prior to their use and in the event there is cause to believe that the scales are performing incorrectly, he shall furnish additional certification.

The scales shall be equipped with an approved automatic printer system which will print the tare weight as well as the total weight of the unit and the mix.

In lieu of platform scales the contractor may weigh the mixture in a weigh box located under the surge or storage bin prior to loading into a truck provided the scales meet the requirements given in the preceding paragraphs.

(b) Batch Plants: When batch plants are used, the contractor, at his option, can use either gradation control by means of screens or cold feed control without separating the dried aggregate into two or more sizes. If cold feed control is selected, a scalping screen will be required. The details of equipment requirements for each mode of operation shall be as described herein and the general requirements given in Heading (a) of this subsection.

(1) **Screens:** Plant screens capable of screening all aggregates to the sizes required for proportioning, and having normal capacity in excess of the full capacity of the mixer or the dryer, shall be provided. The con-

tractor shall expose the screens for inspection at the request of the engineer.

(2) **Bins:** The bin sizes shall be adequate for continuous operation of the plant at rated capacity. Bins shall be so arranged to insure separate and adequate storage of appropriate fractions of the aggregate. Adequate dry storage shall be provided for the mineral filler and provisions made for proportioning the filler for each batch of mixture. Each hot bin shall be provided with an overflow pipe or chute (except the mineral filler bin) to prevent contamination of materials. Each size of aggregate, as required, shall be stored in separate bins when screens are used.

For screenless operation, aggregate shall be stored in one or more bins with adequate provisions to prevent segregation.

(3) **Weigh Box or Hopper:** Equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales ample in size to hold a full batch. Gates on both bins and hopper shall be so constructed as to prevent leakage when they are closed.

(4) **Plant Scales:** Scales for any weigh box or hopper shall be the springless dial type and shall be of a standard make and design, accurate to 0.5 percent of the indicated load. They shall be designed, constructed and installed in such a manner as to be reasonably free from vibration.

All scales for weighing the asphalt shall have a capacity which will insure accuracy within the tolerance specified elsewhere herein. Scales shall be tested as often as deemed necessary to insure their accuracy as directed by the engineer.

The contractor shall also provide an approved printer system which will print separately the weight of the aggregate and of the asphalt.

In the event of a breakdown of the printing mechanism, the contractor will be permitted to operate through a maximum period of 48 hours (two consecutive calendar days) from the time of the breakdown.

(5) **Control of Mixing Time:** The mixer shall have an approved timing device to prevent the entrance of additional material while the mixing operation is in progress, and the discharge gates shall be locked to insure proper mixing. The device shall also lock the asphalt bucket throughout the dry mixing period.

(c) **Continuous Mix Plants:** When continuous plants are used, the contractor, at his option, can use either gradation control by means of screens or cold feed without separating the dried aggregate. If cold feed control is selected, a scalping screen will be required. The details of equipment requirements for continuous mix plants shall be as described herein and the general requirements given in Heading (a) of this subsection.

(1) **Gradation Control Unit:** The plant shall include a means for accurately proportioning each size of aggregate by volumetric measurement. The unit shall include a feeder mounted under the bins with each bin compartment having an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from it. The orifice shall be rectangular, with one dimension adjustable by positive mechanical adjustment, and provided with a lock. Indicators shall be provided on each gate to show the gate opening in inches. If cold feed control is selected, one or more bins may be used for aggregate. Mineral filler, when specified, shall be proportioned separately from a hopper equipped with an adjustable feed which may be accurately and conveniently calibrated and which shall be interlocked with the aggregate and asphalt feeds.

(2) **Weight Calibration of Aggregate Feed:** Samples shall be taken and weighed as a means of calibrating gate openings. Material shall be fed out of a bin through the individual orifice and bypassed to an approved test box. The material from each compartment shall be taken separately. The plant shall be equipped to handle conveniently such test samples weighing not less than 200 pounds. An accurate platform scale shall be provided by the contractor to weigh the test samples.

(3) **Synchronization of Aggregate and Asphalt Feed:** Satisfactory means shall be provided to assure positive interlocking control between the flow of aggregate from the bins and the flow of asphalt from the meter or other proportioning device. This shall be accomplished by interlocking mechanical means or by any positive method approved by the engineer. The aggregate bins shall be provided with signal devices and controls which will warn of low levels and which will automatically stop the flow of all aggregate and asphalt to the mixer when the aggregate in any one bin is so low that the feeder will not operate at set capacity. The asphalt storage system shall be provided with signal devices and controls which will warn of low levels of asphalt and which will automatically stop the entire plant operation when the asphalt storage level is lowered to the point of exposing the feed end of the asphalt suction line.

If mineral filler is specified, the plant shall include separate equipment to accurately proportion the mineral filler sufficiently in advance of the addition of the asphalt to give a proper dry mix time. This equipment shall be of such design as to give a constant flow of the material and shall include a storage bin of sufficient capacity and an adjustable calibrated gate. The filler feed system shall be interlocked with the aggregate control system and feed the material by mechanical means. A gravity type feed will not be permitted. When dust collected in bag houses is allowed for mineral filler, it may be added into the stream of dried aggregate provided the proper proportions can be assured.

(4) Control of Mixing Time: The plant shall be equipped with a positive means to govern the time of mixing. Mixing time shall not be altered unless approved by the engineer.

(5) Discharge Box: The plant shall be equipped with either a discharge box of sufficient size to collect the mix as it comes out of the pugmill to prevent segregation, or a surge bin meeting the requirements of Subsection 501.06.

(d) Dryer-drum Plants: The details of equipment requirements shall be as described herein and the general requirements given under Heading (a) of this Subsection.

(1) The complete dryer-drum process, including plant with necessary auxiliary equipment and controls, operating procedures, and testing and sampling methods during operation, must be approved by the Department prior to use.

All new dryer-drum plants are required to demonstrate their ability to produce mixes that will meet specification requirements before placing final surface course.

(2) The system shall provide positive weight control of the cold aggregate feed by use of a belt scale or other device which is automatically coupled with the asphalt flow and interlocked with the asphalt measuring system to maintain the required proportions. The weighing will be continuous and be accurate to 0.5 percent. Proportioning of the mixture shall be in accordance with the job mix formula and within the allowable tolerances for control of mixtures. The system shall be equipped with automatic burner controls and shall provide for temperature sensing of the mixture at discharge.

The cold aggregate bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation. Scalping screens shall be provided to insure removal of all objectionable materials from the stockpiled materials prior to loading of the aggregates into the cold feed bins. An additional scalping screen will be required between the cold feed discharge and dryer in advance of the belt scale.

Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight.

Dry or wet weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized. The rate of flow of asphalt used will also be digitally displayed and totalized.

Means shall be provided for conveniently diverting aggregate delivery into trucks, front end loaders, or other containers for checking the accuracy of the aggregate delivery system.

(3) The asphalt pump shall be a positive displacement type pump. The asphalt storage system shall be equipped with a device for automatic plant shut-off when the intake of the pump is not working under required pressure.

For mineral filler a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders. Mineral filler shall be introduced directly into the drum by approved means.

When the automatic asphalt adjustments or any other critical control and shutoff devices are not functioning, the plant will not be permitted to operate.

(4) The plant will be equipped with a surge bin meeting the requirements of Subsection 501.06.

501.06 STORAGE SILOS AND SURGE BINS. The contractor may use storage silos or surge bins for storing asphaltic concrete mixtures with the approval of the Department and provided it is not detrimental to the mix.

(a) Heated Storage Silos: The bins shall be such that mix drawn from the bin meets the same requirements as mix loaded directly into the trucks from the pugmill for delivery to the job.

The system shall be capable of conveying the hot mix from the plant to the silo by means of a drag-slat conveyor system or other approved systems. The conveyor may be enclosed and heated to prevent a drop in the mix temperature; however, hot air shall not be blown on the mix. The conveyor shall be of a continuous type designed to prevent spillage and to remove the mix from the plant as fast as it is produced.

(1) Heating: The silo shall be insulated and may be heated electrically, or with hot oil or hot air.

The atmosphere within the silo may be air or inert gas. The storage silo heating system shall be capable of maintaining the mix temperature without localized heating (hot spots). If inert gas is used, the inert gas system must be capable of purging the silo with an oxygen free (inert) atmosphere and then sealing the silo to prevent the loss of the inert gas.

(2) Maximum Allowable Storage Time: The maximum allowable storage time of the hot mix in the heated storage silo shall be as follows:

	Storage Time-Hours	
	Fine Mix (3/4'' max. agg. size)	**Coarse Mix (1-1/2'' max. agg. size)**
Silicone treated asphalt, air in bin	36	18
Silicone treated asphalt, inert gas	144	72

After the storage silo is in use for some time, the Department may grant the contractor permission to exceed the above storage times, provided test results and other data indicate that the additional storage time is not detrimental to the mix.

(b) Unheated Surge Bins: The bins shall be such that the mix drawn from the bin meets the same requirements as mix loaded directly into the trucks from the mixing unit for delivery to the job.

The system shall be capable of conveying the hot mix from the plant to the bin by means of a drag-slat conveyor system or other approved systems. The conveyor shall be of a continuous type designed to prevent spillage and to remove the mix from the plant as fast as it is produced. The maximum allowable storage time for unheated surge bins shall be two hours.

(c) General Requirements for Storage Silos and Surge Bins:

(1) Transporting the Mix from the Plant: The mix may be transported directly from the plant to the storage silo or surge bins by means of the conveyor system or it may be trucked from the plant to the site of the storage silo or surge bin and then transported into the bin by means of the conveyor system, as long as the mix remains within $\pm 15°F$ of the plant discharge temperature.

When the mixture is placed into the bin through a surge device, an automatic warning system shall be provided which will automatically warn the operator of a malfunction of the gates.

(2) Unloading: The storage silo or surge bin unloading gates may be clam gates operating under gravity feed, or any other type gate which will not cause segregation or be detrimental to the mix in any way.

501.07 HAULING EQUIPMENT. Vehicles used for the transportation of asphaltic mixtures shall have tight, clean, smooth metal beds. The vehicle beds shall be painted or sprayed at least once a day or as often as required with lime water, soap solution or an approved asphalt release agent shown on the Department's Qualified Products List.

Each vehicle shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. When job conditions necessitate, covers shall be securely fastened.

The hauling unit shall discharge the mixture in a continuous manner so the spreader apron of the paver will not be overloaded. The truck bed shall not rest directly on the apron of spreader. Trucks that are to be pushed by paver shall be of such size and capacity that the paver will push them without affecting the surface smoothness or the edge line of the mixture. Any distortions in the surface finish resulting from improper unloading of the mixture shall be corrected immediately.

When the size, speed and condition of trucks are such as to interfere with the orderly paving operation, the engineer may order suitable substitution to

be made. The load limits for the hauling units shall be determined by the engineer to be within the load carrying capacity of the roadbed or pavement structure, as the case may be and shall meet the legal load limits. Any unit that causes damage to the existing roadbed or pavement structure shall not be used and all damages shall be repaired by the contractor at no additional cost to the Department.

501.08 PAVING EQUIPMENT. Pavers shall be the conventional self-powered pavers, or pavers equipped with automatic screed and slope control devices for use with a minimum 30-foot traveling stringline or with an erected stringline. The project specifications will state the type or types of paver controls required for the project. If paver controls are not specified in the project specifications, paver controls will be as directed by the engineer.

(a) Conventional Pavers: Pavers shall be capable of laying mixtures within the tolerances specified. A screed or strike-off assembly shall be used, distributing the mixture either over the entire width or over such partial lane widths as may be practicable. The assembly shall be adjustable to give the cross section shape as indicated on the plan typical sections. The screed shall be equipped with a heater.

Pavers shall be equipped with hoppers and distributing screws to place the mix evenly in front of an adjustable screed. They shall be equipped with a quick and efficient steering device and shall be capable of traveling both forward and in reverse.

Pavers shall be capable of spreading mixes to required thickness without segregation or tearing.

Unless otherwise specified, when leveling is required by the plans, a blade grader may be used when approval is given by the engineer.

In shoulder construction, modified conventional spreaders or widener spreaders shall be provided.

(b) Pavers with Automatic Screed Control: This type paver shall meet the same requirements as described above for conventional pavers and shall be equipped with automatic screed and slope control devices capable of laying the mixture to grade within the tolerances specified, distributing the mixture over the entire width or over such partial lane widths as may be practicable. Pavers shall be equipped with two sensors when required.

The pavers shall be equipped to work from an erected stringline or a traveling stringline that will accurately reflect, for a minimum 30-foot length, the average grade of the surface on which it is to be operated. Pavers shall also be equipped with a shoe attachment to control the grade of a lane being placed adjacent to a previously placed lane.

If a malfunction occurs in the automatic screed control device during laydown operations, work may continue for the balance of that day on any

course other than the final surface course. Any overrun resulting from placing material without the automatic screed control device shall be borne by the contractor. If a screed control device malfunctions during final surface course paving operations, plant operations will be discontinued immediately and shall not be resumed until the screed malfunction has been remedied. Material in transit may be placed, provided all surface and grade tolerances are met.

501.09 ROLLERS. Rollers shall be self-propelled and shall be in good condition, capable of reversing without backlash. The number and weight of the rollers shall be sufficient to compact the mixture to the required density and surface smoothness while it is still in a workable condition and shall be capable of maintaining the pace of the paver. The use of equipment which results in crushing of the aggregate will not be permitted. Vibratory rollers with separate controls for energy and propulsion and especially designed for asphaltic concrete compaction may be used provided the vibratory rollers do not impair the stability of the pavement structure and any underlying layers.

All rollers shall have suitable equipment for keeping rollers or tires clean and efficiently dispensing water to the contact surfaces to prevent mixture pickup.

The Department reserves the right to reject poorly performing rollers and require that they be replaced with suitable equipment or supplemented as may be necessary to accomplish the desired results.

501.10 INCIDENTAL EQUIPMENT AND HAND TOOLS. Power revolving brooms or power blowers and distributors shall be provided and maintained in a satisfactory working condition.

Tamping tools used to consolidate the edges of the binder and wearing courses shall be of sufficient weight to compact the edges to the same degree as the body of the pavement. Satisfactory mechanical equipment may be used instead of tamping tools.

The distributor shall be equipped with suitable manifold and appliance so designed as to distribute evenly heated material within the temperature range specified with positive controlled heat and temperature at all times, and shall be equipped with thermometers to indicate the temperature of the material in the tank. The distributor shall be so designed as to maintain a constant and uniform pressure upon the asphaltic material as it passes through the nozzles.

The distributor shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of asphaltic materials being applied per square yard of surface under the operating conditions, and shall have a tachometer, reading speeds in feet per minute. The distributor shall be so designed as to apply asphaltic material at the specified rate.

501.11 HANDLING AND PROCESSING OF AGGREGATES. Coarse and fine aggregates shall be stored at the plant site in such a manner

that the separate sizes will not become intermixed.

When stockpiling, the material shall be placed to minimize segregation of aggregate sizes.

Blending of aggregates in stockpiles or on the ground at the plant site or at the source will not be permitted.

The gradation for the individual stockpiles and proportioning from these stockpiles will be the contractor's responsibility. The gradation of the aggregate in the stockpiles shall be such that when the aggregates are combined in the proper proportions, the resulting combined gradation will meet the requirements of the job mix formula.

The proportioning of the material at the cold feed will be established by the contractor to meet the job mix gradation requirements.

This will be done in such a manner that when plants operate with only cold feed control further manipulation will not be necessary to meet job mix requirements.

(a) Drying: For all plants the aggregate shall be heated and dried to produce a paving mixture meeting the requirements of the specifications.

The quantity of material fed through the dryer shall be held to an amount which can be adequately heated and dried. If proper drying is not achieved and the quality of the mix is impaired, the contractor shall adjust the rate of production of the dryer, as required to obtain satisfactory results.

(b) When screens are used, aggregates shall be screened into sizes such that they may be combined into a gradation meeting the requirements of the job mix formula.

(c) Hot Aggregate Storage: In all plants, except dryer-drum plant, hot aggregate shall be stored in bins. Storage shall be accomplished in such a manner as to minimize segregation and loss of temperature of the aggregate. If the plant operation is interrupted and the temperature of the material in the hot storage cools to 25°F or more below the specified mixing temperature, the bins shall be pulled and the material discarded.

501.12 PROCESSING OF ASPHALT AND AGGREGATES. The aggregates shall be combined, either prior to or after drying, depending on the type of plant used, to meet the job mix formula. The asphalt shall be measured and introduced into the mixer or the dryer in the quantities specified in the job mix formula.

In case of conventional plants with pugmills, prior to adding asphalt cement, the combined mineral aggregate shall be thoroughly mixed dry, after which the proper amount of asphalt shall be sprayed over the mineral aggregate and mixed to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated. The mixing time shall be submitted by the contractor in the job mix formula and approved by the engineer.

In case of dryer-drum plants, the aggregate and asphalt shall be fed into the dryer-drum in such a manner that the aggregates are adequately coated with asphalt.

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of materials.

The fuel used must be clean burning so there is no contamination of the mixture.

Physical properties of the mixture will be determined at the plant by the Department and shall conform to Table V of this Section. Aggregate or mixes contaminated with carbon or oil will be rejected.

The aggregate, asphalt and the mixture will be processed at the temperature specified in the job mix formula. The temperature of the mixture at discharge from the mixer shall be within $\pm 25°F$ of the temperature approved in the job mix formula provided the mixing, coating, placing and density requirements are met.

In case of dryer-drum plants, the moisture content of mixture shall be minimized and uniformly controlled in order to insure that placing and density requirements are met. The contractor's technician will be required to measure the moisture content of aggregate when starting the plant and adequate scheduled tests during plant operations and adjustments to plant shall be made accordingly. The engineer shall approve the schedule for moisture content testing.

When dryer-drum plants are used, approved means shall be provided to divert and waste the first and the last output of the plant after each interruption that results in a change in mix quality.

501.13 WEATHER LIMITATIONS. Asphaltic concrete plant mix shall not be applied on a wet surface, except that material in transit at the time the plant operation is discontinued may be laid, subject to the end product meeting specifications.

Placement of the mixture shall be discontinued when the descending air temperature in the shade and away from artificial heat reaches 45°F and shall not be resumed until the ascending temperature reaches 40°F.

If the work consists of placing material in lift thicknesses greater than 3 inches, these temperature limitations shall not apply provided all other requirements of the specifications are met.

501.14 CONDITIONING OF EXISTING SURFACE. The surface to be covered shall be swept clean and free from dust and dirt, caked clay and loose foreign material by means of revolving brooms or other approved mechanical sweepers supplemented by hand brooms, as directed.

When the mixture is to be placed on an existing pavement, the contractor shall, in addition to cleaning the surface as required above, remove excess

joint filler from the surface by an approved burning method. This does not relieve the contractor from maintaining the existing pavement at his expense.

Contact surfaces of curbs, gutters, manholes, longitudinal joints and other structures shall be painted with a thin uniform coating of tack coat before the asphaltic mixture is placed against them.

The condition of the base shall be approved prior to the placing of the mixture.

501.15 JOINTS. The longitudinal joints in one layer shall offset that in the layer immediately below by approximately 3 inches; however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises 2 lanes of width, or at lane lines if the roadway is more than 2 lanes.

Transverse joints shall be butt joints formed by cutting back on the previous run to expose the full depth of the course. Transverse joints in succeeding courses shall be offset at least 2 feet. When directed, a brush coat of asphaltic material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

501.16 TACK AND PRIME COAT. Before constructing each course, a tack coat of the width indicated on the plans shall be applied if needed at the rate specified by the engineer in accordance with Section 503. The responsibility for the protection of the tack coat shall rest with the contractor, and required spot-patching shall be made at no extra cost.

Asphaltic concrete shall not be applied on a tacked surface or primed base until the asphaltic material has cured to the satisfaction of the engineer.

If asphaltic concrete is to be placed on an aggregate type base course, the contractor shall use a prime coat as described in Section 504 in lieu of the tack coat required herein.

If the primer has dried out or is otherwise insufficient prior to laying the asphaltic concrete, the contractor shall, at his expense, re-prime the base or apply a light tack coat as directed; however, the primed surface shall be completely cured to the satisfaction of the engineer.

Unless pay items for tack coat and prime coat are provided for in the contract, these items will not be paid for directly but will be considered incidental to the bid items.

501.17 SPREADING AND FINISHING. The mixture shall be transported from the mixing plant and delivered at the site of work at a temperature no cooler than 25°F below the minimum allowable temperature of the mixture when discharged from the mixer. No loads shall be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless artificial light is approved by the engineer.

The laying operations shall be conducted in the following manner:

(a) Coordination of Production: The contractor shall coordinate and

manage the plant production, the transportation of the mix and the laying operation to achieve a high quality pavement. He shall have sufficient hauling vehicles to insure more or less continuous plant and roadway operation with a minimum idle time between loads. The Department reserves the right to order a halt to operations if sufficient hauling vehicles are not available. If less than the optimum number of hauling vehicles are available and it is determined that satisfactory quality can be obtained, the contractor will be permitted to work provided the plant production and the hauling vehicles are coordinated to minimize the effect of idle time between loads.

(b) Pavers: The pavers used shall be one of the types described in Subsection 501.08 as specified by the project specifications or as directed by the engineer.

If the spreading and finishing operation is interrupted to such extent that some of the mixture remaining in the trucks, spreader, spreader hopper or on the roadway cools to where it cannot be laid, finished or compacted to the same degree of smoothness and with the same texture and density as the uncooled mixture, the cooled mixture shall be removed and replaced at the contractor's expense.

The following requirements shall apply for mechanical spreaders with automatic screed control:

(1) Automatic Screed Control with Minimum 30-Foot Traveling Stringline: The initial lane of each course to be laid, whether it be wearing, leveling, base, binder, or a combination of any of these courses, shall be constructed in the approximate lifts shown on the plans using the traveling stringline method; however, if field conditions warrant, the portion of the leveling course required to level isolated depressions may be placed without the automatic screed control device.

After the initial lane of each course is finished and compacted, the adjacent lane or lanes on that course shall be laid to the grade of the initial lane, using a grade sensor to control grade and controlling the cross slope with the slope control device.

If field conditions warrant, the traveling stringline may be used to control the grade of any adjacent lane on all courses with the exception of the final wearing course.

In cases where both of the outside edges of the lane being placed are flush with previously placed material, the slope device shall not be used. A grade sensor may be required for each side of the spreader.

When three or more contiguous lanes are to be constructed, the order of construction shall be as directed. The courses placed in lanes which are not adjacent to a lane previously placed with the traveling stringline shall be constructed using the traveling stringline.

In superelevated curves, the cross slope shall be changed from that specified for tangents to that specified for superelevation in gradual increments as the paver is in motion so that smooth transition in grade is obtained. This change in cross slope shall be accomplished within the transition distance specified.

(2) Automatic Screed Control with Erected Stringline: The initial lane of the first course to be laid, whether it be leveling, base, binder or a combination of any of the three, shall be controlled by an erected stringline referenced to grade stakes established by the engineer; however, if field conditions warrant, the portion of the leveling course required to level depressions may be placed without the automatic screed control device.

The paver shall be positioned and operated to closely follow the established line. Only one sensor and the slope control device are necessary for normal crown on tangents. Superelevated curves will require the use of two sensors and two erected stringlines to obtain proper grade and slope; however, if the automatic screed control device furnished by the contractor is equipped with a dial or other device which can be conveniently used to change the cross slope in small increments, superelevated curves may be constructed using this device and one erected stringline.

After the initial lane of the first course is finished and compacted, the adjacent lane or lanes on the first course will be laid to the grade of the initial lane, using a grade sensor to control grade and controlling the cross slope with the slope control device.

If field conditions warrant, the traveling stringline may be used to control the grade of any adjacent lane on all courses with the exception of the final wearing course unless otherwise directed by the engineer.

In superelevated curves, erected stringlines will be used to control the grade of the edge opposite the initial lane; however, if the automatic screed control device furnished by the contractor is equipped with a dial or other device which can be conveniently used to change the cross slope in small increments, superelevated curves may be constructed using this device and one erected stringline. Subsequent courses may be controlled by use of the traveling stringline attached to the paver, provided all surface and grade tolerances are met on the previous course.

In cases where both of the outside edges of the lane being placed are flush with previously placed material, the slope device will not be used. A grade sensor may be required for each side of the spreader.

In cases where only one course is to be constructed in one lift, the first lane laid will be controlled by use of an erected stringline referenced to grade as described above unless otherwise directed. The adjacent lane or lanes will be controlled as described above.

When three or more contiguous lanes are to be constructed, the order of construction shall be as directed, and subsequent first course lanes which are not adjacent to a previously placed initial lane shall be considered an initial lane.

Transfer of the asphaltic mixture from the haul truck to the spreader may be made by direct unloading into the spreader hopper by use of approved mechanical loading devices or by direct dumping on the roadbed. When the mixture is dumped directly on the roadbed, approved loading equipment will be used to transfer the mixture into the finishing machine, and the equipment shall be constructed and operated in such a manner that substantially all of the mixture deposited on the roadbed is picked up without contamination by foreign material. The equipment shall be so designed and operated that the finishing machine will place the mixture to the required line, grade and surface without resorting to hand finishing. Any operation of the equipment resulting in the accumulation and subsequent shedding of this accumulated material into the asphaltic mixture will not be permitted.

Equipment which leaves tracks or indented areas which cannot be corrected in normal operations or which produces flushing or other permanent blemishes or fails to produce a satisfactory surface shall not be used.

Longitudinal joints and edges shall be constructed along reasonably true lines. These lines shall be established by the engineer parallel to the centerline of the proposed roadway, and stringlines or other devices shall be placed by the contractor for the paver to follow in placing individual lanes. The paver shall be positioned and operated to closely follow the established line. Delivery of material to the paver shall be at a uniform rate and in an amount within the capacity of the paving and compacting equipment.

As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. The adjustment of the screed, tamping bars, feed screws, hopper feed, etc., shall be checked frequently to assure uniform spreading of the mix to the proper line and grade and adequate initial compaction. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected.

Longitudinal and transverse joints shall be formed as provided in Subsection 501.15.

Any irregularities in alignment left by the paver shall be corrected by trimming directly behind the machine. Immediately after trimming, the edge of the course shall be thoroughly compacted by tamping. Distortion of the pavement during this operation shall be avoided. Edges against which additional material is to be placed shall be reasonably formed to lines and approximately vertical. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material form-

ing high spots shall be removed. Indented areas shall be filled with hot mix and finished reasonably smooth. Casting of material over the surface will not be permitted whenever wearing course is being laid.

The outside edge of the freshly laid mixture shall be tamped, behind the spreader prior to rolling, to reasonably vertical edge whenever base or binder courses are being laid, and to approximately 45° beveled edge when the wearing courses are being laid.

(c) Hand Spreading: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand. Approved wood or steel forms, rigidly supported to assure reasonably correct grade and cross section, may be used. In such instances, measuring blocks and intermediate strips shall be used to aid in obtaining the required cross section. During the spreading operation, all material shall be thoroughly loosened and uniformly distributed. Material that has formed into lumps and does not break down readily will be rejected. Following placing and before rolling, the surface shall be checked and all irregularities corrected.

501.18 COMPACTION. After spreading and striking off and while still hot, each course shall be thoroughly and uniformly compacted by rolling.

The highest contact pressure that will give the required density shall be used for any pneumatic roller.

When used the pneumatic-tire roller shall be kept approximately 6 inches from the unsupported centerline joint when only one lane is in place. However, when both lanes are down, it shall be overlapped at least 6 inches to get additional sealing of the joint.

Rolling shall be conducted in such sequence and by methods that will obtain the specified density and smoothness requirements. Each roller shall be operated by a competent, experienced operator and, while the work is under way, shall be kept as nearly as practicable in continuous operation.

The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller or from any other cause shall be immediately corrected. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened when needed but excess water will not be permitted. Rolling shall continue until all roller marks have been eliminated.

Along forms, curbs, headers and walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers or mechanical tampers to obtain a satisfactory density.

The surface of the mixture after compaction shall be smooth and true to the established cross slope and grade within the tolerances specified. Any mixture that becomes loose, broken, contaminated or in any way defective shall

be removed and replaced with fresh hot mixture which shall be immediately compacted to conform with the surrounding area.

501.19 PROTECTION OF PAVEMENT. Sections of newly finished pavement shall be protected from traffic until the pavement has sufficiently hardened.

501.20 PAVEMENT SAMPLES. The contractor shall furnish for testing, when required, samples cut from the completed work. The area of pavement so removed shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and replacing the areas with new pavement.

Samples of the finished roadway will be taken by the contractor in the presence of the engineer's representative from areas selected by the engineer. Saws or core drills of an approved type will be required. The size of each sample shall be approximately 4 inches square or 4 inches in diameter.

501.21 SURFACE FINISH REQUIREMENTS. Control testing for surface tolerance will be the responsibility of the Department. Control testing will be required only on the binder course or shoulder mixes. The binder course will be defined as the last course to be laid prior to the wearing course, friction course excluded.

Base course mixtures on which portland cement conrete pavement is to be placed shall be finished in such manner that the pavement will meet the acceptance requirements of Section 601. Base course mixtures on which additional asphaltic concrete is to be placed shall be finished in such manner that the succeeding courses will meet the acceptance requirements specified in this Section.

Variations in surface finish, cross slope and grade of the binder or shoulder mix shall not exceed the values shown in Table II. If the use of an automatic screed control device is required, the allowable variation shown in Part A of Table II shall apply. If the use of an automatic screed control device is not required, the allowable variation shown in Part B of Table II shall apply.

The finished surface will be tested by the engineer in both the longitudinal and transverse directions for conformance to the specifications for surface finish. The contractor shall furnish a 10-foot rolling straightedge acceptable to the engineer for testing in the longitudinal direction and a 12-foot metal static straightedge for testing in the transverse direction.

In the longitudinal direction, one path in each lane will be selected at random in accordance with the Department's Materials Sampling Manual. The entire lot will be tested.

Variations in the surface, when tested for the tolerance shown in Table II, shall not show more than 3 percent outside of the tolerance for a given lot. If greater than 3 percent is outside the tolerance, the deficiencies shall be corrected. In the transverse direction, random sites will be selected for testing.

TABLE II
Allowable Variation

Mixtures	Part A				Part B			
	Longi-tudinal	Trans-verse	Cross Slope	Grade (1)	Longi-tudinal	Trans-verse	Cross Slope	Grade (1)
Wearing Course (Final Surface)	1/8" (2)	1/8"	3/8"	1/2"	3/16" (2)	3/16"	3/8"	1/2"
Binder Course (3)	1/4"	1/4"	1/2"	1/2"	3/8"	3/8"	1"	1/2"
Base Course	3/16"	3/16"	3/4"	3/4"	3/16"	3/16"	3/4"	3/4"
Shoulder Mix	3/16"	3/16"	3/4"	3/4"	3/16"	3/16"	3/4"	3/4"

(1) Applicable only when grade is specified.
(2) Longitudinal wearing course final surface tolerances to be used for acceptance testing.
(3) These tolerances are to be used for job control testing of wearing course lifts in other than the final wearing course lift.

Variations of the surface from the testing edge contacts with the surface shall not exceed the values shown in Table II. Variation in surface finish allowed by Table II shall apply to a 10-foot length.

(a) Cross Slope: When the plans require the section to be constructed to a specified cross slope, tests for conformance shall be run at selected locations, using a stringline, slope board or other comparable method. Variations of the cross slope shall not exceed the values shown in Table II. Variations in cross slope allowed by Table II shall apply to the width of one lane.

(b) Grade: When the plans require the pavement to be constructed to a grade, tests for conformance shall be run at selected locations, using a stringline or other comparable method. Maximum deviation from grade shown on the plans, or as altered by the engineer, shall not exceed the values shown in Table II. If the engineer finds that the pavement is consistently above or below the proposed finish grade for a reasonably long segment, he may, for the purpose of determining conformance to the grade tolerance specified in Table II, use a new grade approximately parallel to and above or below the established grade; in which case, any required transition in grade or vertical curve at each extremity of the segment will be

in accordance with the best design requirements. Variations in grade allowed by Table II shall apply to only one longitudinal line such as the centerline, outside edge of pavement, etc. The engineer will designate the longitudinal line to which this variation shall apply.

When the total depth of mixture constructed, exclusive of leveling course and friction course, is less than 3½ inches, Part B of Table II will apply. When total depth of mixture constructed, exclusive of leveling course and friction course, is 3½ inches or greater, Part A of Table II will apply.

If any single surface tolerance measurement exceeds the specification requirements by more than ½ of the tolerance specified, the deficient area shall be corrected. If less than 97 percent of all surface tolerance measurements per lot meet these tolerances, all deficient areas shall be corrected.

(c) **Correction of Deficient Areas:** Irregularities in the binder course, shoulder course or base course may be corrected by either skin patching, featheredging, wedge course construction, or full depth patching, where appropriate, and where it can be completed in a satisfactory manner at no additional expense to the Department.

501.22 ACCEPTANCE REQUIREMENTS. Asphaltic concrete mixture will be accepted on the basis of the following requirements for (a) Marshall Stability, (b) Roadway Density, (c) Surface Tolerance and (d) Aggregate Gradation.

In addition to the foregoing acceptance requirements, mixtures that are specified for payment by the cubic yard or square yard will be accepted on the basis of dimensional requirements in accordance with Heading (e) of this subsection.

(a) **Marshall Stability:** The contractor shall design his mix with the intent that compacted specimens of the mixture shall conform to the properties in Table III when tested in accordance with DOTD Designation: TR 305, for an average of four samples taken from each lot after it is placed in the trucks using random sampling procedures. A lot shall be considered as one day's production. A stratified random sampling plan shall be utilized such that two of the four samples are obtained during the first half of the workday and the other two during the second half of the work day in accordance with the Department's Materials Sampling Manual. The time at which these acceptance samples are obtained from the trucks shall be set by the engineer using random number tables.

The acceptance testing and final approval of the mixture will be the responsibility of the Department except aggregate gradation testing as described under Heading (d) of this Subsection.

When the average of four tests is outside of the acceptance limits specified for the average of the four tests results for Marshall stability, an adjustment in the unit price for the lot of the mixture shall be made as further out-

TABLE III

Type of Mix	Acceptance Limits for Marshall Stability Average of: (Samples)			
	4	3	2	1
Type 1, 2, 4				
AC-40, BC & WC.....	1200 Min.	1150 Min.	1050 Min.	900 Min.
AC-20, BC & WC.....	1100 Min.	1050 Min.	1000 Min.	800 Min.
Type 3				
AC-40, BC.....	1400 Min.	1350 Min.	1250 Min.	1050 Min.
AC-40, WC.....	1700 Min.	1600 Min.	1500 Min.	1250 Min.
Type 5 Base Course				
AC-40 (A).....	1200 Min.	1150 Min.	1050 Min.	900 Min.
AC-20 (B).....	800 Min.	750 Min.	700 Min.	600 Min.
Shoulder, BC & WC..... All types	1000 Min.	950 Min.	900 Min.	800 Min.

lined. No adjustment in the unit price will be made for mixture being outside the limits on the individual results except as noted below.

When it is not possible to sample the whole lot (four samples) due to unfavorable circumstances caused by plant breakdown or inclement weather or other causes, the acceptance limits will be as shown in Table III as based on the number of tests made during the time the plant was in operation. In no event will the number of tests or samples be less than four for eight hours of plant operation and less than two for four hours of operation.

If the plant operates for less than four hours and only one sample has been obtained, the mix will be accepted on the basis of limits for one sample.

When the average of the number of tests representing the period the plant was in operation for the day is outside the acceptance limits for Marshall stability shown in Table III for the average of the number of samples tested during the day, an adjustment in the unit price for the lot of the mixture represented by the number of samples will be made in accordance with Subsection 501.25.

(b) Roadway Density: Upon completion of compaction, five pavement samples will be obtained from each compacted lot at locations determined in accordance with the stratified random sampling plan within 24 hours after placement of the mix. If this falls on a day the contractor's crews are not working, the sampling will be done the following work day. A lot will be considered as the number of linear feet of mix laid during the day's operation. The linear feet laid during the day will be divided into five

TABLE IV

	Type of Mix	Acceptance Limits for Roadway Density Average 5 Samples (Percent)
Traffic Lanes	1 and 4	95
Traffic Lanes	2	92
Traffic Lanes	3	95
Traffic Lanes	5A	95(2)
Traffic Lanes	5B	95(1)(2)
Shoulders	All Mixes	94(2)

(1) Laboratory density for mix placed under portland cement concrete will be obtained by 50 blows of the compaction hammer.

(2) See Notes (11) and (12) in Table V.

sections of approximately equal length and one sample shall be obtained from each of the five sections using random number tables. In no event will the number of samples representing a full day's production or a fraction thereof be less than five. The density requirement for individual samples and for the average of five samples will be as prescribed in Table IV, when determined in accordance with DOTD Designation: TR 304.

Payment will be made as outlined in Subsection 501.25.

If the sampling location as determined by random sampling indicates obvious bad spots that are to be replaced or falls within two feet of the edge of the pavement, an additional sampling location will be used. Any section that is obviously deficient and may be detrimental to the roadway shall be corrected or replaced regardless of whether it was selected by random or visual observation.

Density requirements for leveling courses or thin overlays may be waived when the engineer deems satisfactory results are obtained.

(c) Surface Tolerance: Acceptance testing for surface tolerance will be required only on the final riding surface. The surface shall be tested by the engineer with a 10-foot rolling straightedge in the longitudinal direction of the pavement only within the time period prescribed in Heading (b) of this subsection. The rolling straightedge shall be furnished by the contractor and shall be calibrated and used in accordance with DOTD Designations: TR 603 and TR 618. A lot will be considered as one day's production of asphaltic concrete.

The requirements for surface tolerance shall be as shown in Table II of Subsection 501.21.

Whenever sections of pavement do not meet the requirements for surface tolerance, an adjustment in unit price for the lot of the mixture shall be made as outlined in Subsection 501.25.

(d) Aggregate Gradation: Acceptance testing for aggregate gradation will be conducted by the contractor's technician and observed by the Department's inspector. Two samples from each lot of mixture produced will be sampled. A lot will be considered as one day's production of a given mixture. One sample will be taken during the first half and another during the second half of the workday using random sampling techniques described in the Department's Materials Sampling Manual. Each sample will be tested in accordance with DOTD Designations: TR 308 and TR 309.

When the average of the test results obtained for acceptance for each lot is outside the control limits for aggregate gradation given in Table I of Subsection 501.04, an adjustment in unit price for the lot will be made in accordance with Subsection 501.25; however, no penalty will be assessed if the succeeding day's lot results in 100 percent payment. This adjustment in unit price is determined by percent deviation from control limits for the No. 4, No. 40 and No. 80 sieves, and only the sieve with the greatest adjustment in contract unit price will be used in assessing the penalty. When the lot is represented by two sieve analysis tests, deviations of gradation will be calculated for each test and the two deviations will be averaged for determination of adjustment in unit price.

(e) Dimensional Tolerances: Mixtures that are specified for payment on a cubic yard or square yard basis shall conform to the following dimensional requirements. Overthickness and overwidth will be waived at no additional cost to the Department.

(1) Thickness: The thickness of the mixture will be determined on a lot basis, a lot being a day's production of mixture. The thickness of each lot will be the average of the thicknesses of the roadway density samples for the lot. Underthickness of the lot shall not exceed the following tolerances.

Plan Thickness	Underthickness Tolerance
4″ or less	0.25″
More than 4″	0.50″

For all mixtures except the final surface course, lots with underthickness in excess of the foregoing tolerances shall be corrected to plan thickness at the contractor's expense by furnishing and placing additional mixture as required. For the final surface course, lots with underthickness in excess of the foregoing tolerances shall be corrected to plan thickness at the contractor's expense by furnishing and placing a supplemental layer of the wearing course mixture; however, the supplemental layer shall be

TABL

General Requirements f

A. Grading Requirements (7)

U.S. Sieve	Type 1		Type 2	Type 3	
	W.C.	B.C.	W.C. & B.C.	W.C. (1)	B.C.
1½''	—	—	—	—	—
1¼''	—	100	—	—	100
1''	100	90-100	100	100	90-10
¾''	85-100	75-100	90-100	85-100	75-10
½''	70-100	55-95	80-100	70-100	55-9
⅜''	—	—	—	—	—
No. 4	40-70	35-70	50-80	40-70	35-7
No. 10	25-55	20-50	35-65	25-55	20-5
No. 40	8-33	10-33	15-40	8-33	10-3
No. 80	4-20	5-20	4-20	4-20	5-20
No. 200	2-10	2-10	2-10	2-10	2-10
Asphalt %	4.5-7.0	3.8-7.0	4.5-7.5	4.5-7.0	3.8-7.
Aggregate %	93.0-95.5	93.0-96.2	92.5-95.5	93.0-95.5	93.0-9
Mineral Filler % (Min.)(8)	3	2	As Needed	2	2
% Crushed Ret. on No. 4	75 Min.	60 Min.	—	80 Min.	60 Mi
Asphalt Cement (3)	AC-40	AC-40	AC-40	AC-40	AC-4
Coarse Agg. Types (4)	A, B, C	A, B, C, D, E	E	A, B, C	A,B,C,D

B. Minimum Acceptance Requirements for 100% Payment

Marshall Stability (lbs.)(Average of 4 tests)					
AC-20	1100	1100	1100	—	—
AC-40	1200	1200	1200	1700	1400
Density %	95	95	92	95	95
Linear % of Roadway Surf. Tol.					
1/8'' (with Auto. Screed)	0.0-1.0	—	0.0.-1.0 —	0.0-1.0	—
3/16'' (without Auto Screed)	0.0-0.5	—	0.0-0.5 —	0.0-0.5	—

Acceptable Deviation from Control Tolerances or Gradation Limits for Nos. 4, 40 & 80 Sieves: 2% for individua

C. Additional Requirements (6)

Design Mar. Stab. (lbs.)	75 Blows	75 Blows	75 Blows		75 Blows	75 Blow
AC-20	1500	1500	1500		—	—
AC-40	1650	1650	1650		2150	1850
Mar. Flow (1/100'')	15 Max.	15 Max.	15 Max.		15 Max.	15 Max
% Voids (5)	3-5	4-6	3-5	4-6	3-5	4-6
% VFA (5)	70-80	65-75	70-80	65-75	70-80	65-75

(1) Type 3 W.C. mixture shall contain a minimum of 15 percent screenings based on total aggregates.
(2) Type 5B mixture is intended for bases under P.C.C. pavements and shoulder bases and low traffic roads only.
(3) Substitution of AC-20 for AC-40 in Types 1, 2, 4 and 5(A) mixtures must have approval of engineer. No substitutions permitted for Types 3, 5(B) and shoulder mixtures.
(4) Type A — Crushed gravel, B — Crushed slag, C — Crushed stone approved for wearing surface, D — Crushed Stone, E — Crushed clam or reef shell, F — Expanded clay. Crushing not required in base mixtures.
(5) When Type 4 mixture is used for shoulder W.C., design values shall be same as Type 4.
(6) The Materials Engineer may approve deviations from design criteria when conditions warrant.
(7) When W.C. mixture is substituted for binder course, the mix shall meet all physical requirements for wearing course mixtures.
(8) When 100% of the aggregate is crushed limestone, the mineral filler may be reduced or eliminated with prior approval from the engineer. When crushed limestone is used as the coarse aggregate only, the mineral filler will be required as shown.

phaltic Concrete Mixtures

Type 4 (10)	Type 5		Shoulder Mix (9)		Mix Control Tolerances	
W.C. & B.C.	Base (A)	Base (B)(2)	W.C. & B.C.	Base	Individual	Average of 2 Tests
—	100	100		100	± 9	± 6
—	—	—		—	± 9	± 6
—	80-100	80-100		80-100	± 9	± 6
100	70-100	—		—	± 9	± 6
80-100	55-85	—		—	± 12	± 9
—	—	—		—	± 10	± 7
55-85	35-60	35-75		35-75	± 10	± 7
45-75	20-45	—		—	± 9	± 6
20-55	10-30	10-55		10-55	± 7	± 5
10-25	5-25	—		—	± 5	± 4
2-12	2-10	2-15		2-15	± 3	± 2
6.0-8.5	3.5-8.5	3.5-8.5		3.5-8.5	± .6	± .4
91.5-94.0	91.5-96.5	91.5-96.5		91.5-96.6		
2	As Needed	—		—		
—	As Needed	—		—		
AC-40	AC-40	AC-20	AC-20	AC-20		
F	A,B,C,D,E,F	A,B,C,D,E,F	A,B,C,D,E,F	A,B,C,D,E,F		
	1100	1100	800	1000	800	
	1200	1200	—	—	—	
	95	95(12)	95(11)(12)	94	94	
0.0-1.0 —	—	—	—	—	—	
— —	—	—	—	—	—	

% for Average of 2 Tests

75 Blows	75 Blows	50 Blows	50 Blows	50 Blows
1500	1650	1200	1400	1200
1650	1650	—	—	—
15 Max.	15 Max.	15 Max.	8-18	15 Max.
3-7	4-6	3-5	3-5	3-5
65-80	60-75	70-80	75-80	70-80

(9) Requirements not shown are same as shown for applicable Type mix.

10) When Type 3 mixture is specified the contractor will be allowed to furnish Type 4 mixture as an alternate provided the Marshall stability acceptance requirements for Type 3 mixture are met. The adjustment in bid price for Marshall stability shall be in accordance with the requirements for the Type 3 mixture in Schedule No. 1 of Subsection 501.25.

11) The density requirement for mix placed under portland cement concrete will be 94% min. for the first lift and 95% for subsequent lifts. When shell coarse aggregate is used, the density requirement will be 92% min. for all lifts.

12) When shell coarse aggregate is used for Type 5A or 5B mixes not placed under portland cement concrete and the minimum density of 95% cannot be obtained, the following will apply. The contractor must try all possible means of improving density and after this has been done to the satisfaction of the engineer the laboratory may reduce the minimum required density to 93% for 100% pay in accordance with Schedule 2 of Subsection 501.25.

at least 1 inch thick and shall be placed over the entire lot for the full width of the roadway.

(2) **Width:** The width of completed courses will be determined in accordance with DOTD Designation: TR 602. Underwidth of completed base course mixtures shall not exceed 3 inches on each side of the roadway; and underwidth of completed binder and/or wearing course mixtures shall not exceed 1.5 inches on each side of the roadway. Underwidths in excess of the foregoing tolerances shall be corrected to plan width at the contractor's expense by furnishing and placing additional mixture as required.

501.23 SUMMARY OF ASPHALTIC CONCRETE MIX REQUIREMENTS. Table V is a summary of the various asphaltic concrete mixtures and includes (a) Job mix formula requirements, (b) Recommended design criteria and (c) Acceptance limits for 100 percent payment.

501.24 METHOD OF MEASUREMENT. Measurements will be made by one of the following methods as indicated. Unless otherwise provided, tack coat or prime coat required will not be measured for separate payment but will be considered incidental to the asphaltic concrete pay item.

(a) **Weight Measurements:** Aggregates inclusive of mineral filler, and asphalt will be measured by the ton of 2,000 pounds.

When the mixture is produced in a batch plant, measurement of aggregates and asphalt total weight will be determined from the printed weights as provided in Subsection 501.05(b)(4).

When the mixture is produced in (1) a continuous mixing plant, (2) a dryer-drum mixing plant or (3) when mixture is supplied from storage silos and surge bins, measurement will be determined from the printed weights as provided in Subsection 501.05(a)(8).

Stamped printer tickets will be issued for each truck load of material delivered. Material lost, wasted, rejected or applied contrary to these specifications will not be measured for payment.

The estimated quantities shown on the plans and in the proposal are based on gravel, slag and clam shell mixtures. Should the contractor elect to use any of the other allowable mix types, the quantity actually used will be measured and such quantity multiplied by the factor given below for the type used to obtain the quantity for payment.

Mixtures (Wearing, Binder & Base Course)	Factor
Gravel, Slag, or Clam Shell	1.00
Reef Shell Aggregate	1.04
Expanded Clay Aggregate	1.33
Stone, or Stone and Sand	0.97

The aggregate components for each type mixture may vary due to variations in specific gravity. No adjustment will be made for aggregate quantity variation inside the type mixture used.

When a combination of clam shell and reef shell is used for the mixture, the factor used will be 1.00.

(b) Volume or Area Measurement: The quantities for payment will be the design quantities specified in the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary. Design quantities are based on the horizontal dimensions and compacted thickness of the completed course shown on the plans.

Shoulders, when shown on the plans to be separate from the roadway, will be measured by the cubic yard (net section) from dimensions shown on the plans.

501.25 BASIS OF PAYMENT. The accepted quantity of asphaltic concrete will be paid for at the contract unit price per unit of measurement on a lot basis.

Whenever the mix does not conform to the requirements for acceptance of mixes as provided in Subsection 501.22, payment will be made at an adjusted unit price per unit of measurement of asphaltic concrete in accordance with the following.

(a) Adjustment for Stability: When the mix is to be accepted on the basis of the average of four, three, two or one Marshall stability test results, payment for the lot will be adjusted according to Schedule 1.

(b) Adjustment for Roadway Density: Payment per unit price will be adjusted for roadway density as outlined in Schedule 2. The schedule is based upon five samples in a lot.

(c) Adjustment for Surface Tolerance: Payment per unit price for final surface tolerance will be adjusted as listed in Schedule 3 for the lot. The individual surface tolerance requirements for various mixtures are given in Subsection 501.21.

(d) Adjustment for Aggregate Gradation: When the mix is to be accepted on the basis of the average of two or one sieve analysis test deviations from the job mix formula, payment per unit price will be made as indicated in Schedule 4 for the lot. Only the sieve with the least percent payment will be used in assessing penalty.

(e) Final Adjustment in Unit Price Per Lot:

(1) Wearing Course Mixes: The lowest percentage of contract price will be used for final adjustment in unit price for mixes deficient in Marshall stability, roadway density, surface tolerance and aggregate gradation.

Schedule No. 1

ADJUSTMENT IN CONTRACT PRICE PER UNIT OF MEASUREMENT FOR MARSHALL STABILITY

Type 1,2,4 WC, BC Type 5A Base AC-40	Type 1,2,4 WC, BC Type 5A Base AC-20	Type 3 Binder AC-40	Type 3 Wearing AC-40	Type 5B AC-20	Shoulder Mix AC-20	Payment Percent of Contract Unit Price/Lot)
A	Average of Four Marshall Stability Results					
1200 & higher	1100 & higher	1400 & higher	1700 & higher	800 & higher	1000 & higher	100%
1100 to 1199	1000 to 1099	1300 to 1399	1550 to 1699	750 to 799	950 to 999	95%
1000 to 1099	900 to 999	1150 to 1299	1350 to 1549	700 to 749	900 to 949	80%
Below 1000	Below 900	Below 1150	Below 1350	Below 700	Below 900	50% or Remove
B	Average of Three Marshall Stability Results					
1150 & higher	1050 & higher	1350 & higher	1600 & higher	750 & higher	950 & higher	100%
1100 to 1149	1000 to 1049	1300 to 1349	1525 to 1599	700 to 749	900 to 949	95%
1000 to 1099	900 to 999	1150 to 1299	1350 to 1524	650 to 699	850 to 899	80%
Below 1000	Below 900	Below 1150	Below 1350	Below 650	Below 850	50% of Remove
C	Average of Two Marshall Stability Results					
1050 & higher	1000 & higher	1250 & higher	1500 & higher	700 & higher	900 & higher	100%
1000 to 1049	950 to 999	1200 to 1249	1425 to 1499	650 to 699	850 to 899	95%
900 to 999	800 to 949	1050 to 1199	1250 to 1424	600 to 649	800 to 849	80%
Below 900	Below 800	Below 1050	Below 1250	Below 600	Below 800	50% or Remove
D	One Marshall Stability Test Result					
900 & higher	800 & higher	1050 & higher	1250 & higher	600 & higher	800 & higher	100 %
Below 900	Below 800	Below 1050	Below 1250	Below 600	Below 800	50% or Remove

Schedule No. 2
ADJUSTMENT IN CONTRACT PRICE PER UNIT OF MEASUREMENT FOR ROADWAY DENSITY

Average of Five Roadway Samples Minimum Density Requirement (% of Laboratory Density)				Payment (Percent of Contract Unit Price/Lot)
95%	94%	93%	92%	
95 & higher	94 & higher	93 & higher	92 & higher	100%
94 to 94.9	93 to 93.9	91 to 92.9	90 to 91.9	95%
92 to 93.9	91 to 92.9	90 to 90.9	89 to 89.9	80%
Below 92	Below 91	Below 90	Below 89	50% or Remove

Schedule No. 3
ADJUSTMENT IN CONTRACT PRICE PER UNIT OF MEASUREMENT FOR SURFACE TOLERANCE

Linear Percent of Roadway Exceeding Surface Tolerance		Payment (Percent of Contract Unit Price/Lot)
1/8'' Tolerance*	3/16'' Tolerance*	
0.0 to 1.0	0.0 to 0.50	100%
1.1 to 1.5	0.51 to 0.75	95%
1.6 to 2.5	0.76 to 1.5	80%
2.6 or More	1.6 or More	50% or Remove

*The individual surface tolerance requirements for various types of mixes are given in Subsection 501.21.

Schedule No. 4
ADJUSTMENT IN CONTRACT PRICE PER UNIT OF MEASUREMENT FOR GRADATION DEVIATIONS FROM CONTROL LIMITS FOR EXTRACTED AGGREGATE

U.S. Sieve Size			Percent of Contract Unit Price/Lot
No. 4	No. 40	No. 80	
A Average of the deviations of two tests			
0 to 1.0	0 to 1.0	0 to 1.0	100% Payment
1.1 to 4.0	1.1 to 3.0	1.1 to 3.0	98% Payment
More than 4.0	More than 3.0	More than 3.0	95% Payment
B Deviation for One Test			
0 to 2.0	0 to 2.0	0 to 2.0	100% Payment
2.1 to 5.0	2.1 to 4.0	2.1 to 4.0	98% Payment
More than 5.0	More than 4.0	More than 4.0	95% Payment

(2) **Base, Binder and Shoulder Mixes:** The lowest percentage of contract price will be used for final adjustment in unit price for mixes deficient in Marshall stability, roadway density and aggregate gradation.

Surface tolerances for base, binder and shoulder mixes will be controlled in accordance with Subsection 501.21 for job control testing.

(f) **Asphaltic Materials:** In addition to price adjustments specified in Heading (e), payment will be further subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
501(1)	Asphaltic Concrete (_____ Course)	Ton
501(2)	Asphaltic Concrete (_____ Course)	Cubic Yard
501(3)	Asphaltic Concrete (_____ Course) (_____ '' Thick)	Square Yard

Section 502

Asphaltic Concrete Friction Course

502.01 DESCRIPTION. This work consists of furnishing and constructing a thin asphaltic concrete friction course (ACFC) on a prepared surface, in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer.

502.02 COMPOSITION AND QUALITY CONTROL OF MIXTURE. Unless otherwise specified, the friction course shall be composed of asphalt cement with anti-stripping additive and either slag, expanded clay or crushed stone at the contractor's option. The mixture shall be proportioned by weight as follows:

	Percent Asphalt	Percent Aggregate	Percent Crushed Retained on No. 4 Sieve
Slag	6 — 12	88 — 94	——
Expanded Clay	13 — 17	83 — 87	——
Crushed Stone	4 — 10	90 — 96	95 (min.)

The contractor shall submit for the engineer's approval, a job mix formula for the mixture to be supplied for the project. The job mix formula shall be within the allowable tolerances of these specifications. This formula shall consist of proposed gradation, asphalt content, mixing time and mixing temperature. The approved job mix formula for the mixture shall be in effect until a modification is approved by the engineer. Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the contractor may submit a new job mix formula.

The application of job mix formula and allowable tolerances for control of mix shall be in accordance with Subsection 501.04(a), (b) and (d) with the following amendments. Table I of Subsection 501.04(d) is deleted and the following substituted therefor.

TABLE I

JOB MIX FORMULA CONTROL LIMITS

U.S. Sieve	Individual	Average of 2 Tests
⅜ inch	±10	±7
No. 4	±10	±7
No. 10	±9	±6
No. 200	±3	±2
Percent Asphalt	±.6	±.4
*Temperature of Mix °F	±25	±25

*Based on the approved mixing temperature measured after discharge.

Mixing shall be accomplished to give a minimum coating of 95 percent of coarse aggregate particles when tested by AASHTO Designation: T 195.

502.03 AGGREGATES. Slag, expanded clay and crushed stone aggregates shall conform to Subsection 1003.07.

All aggregates will be sampled at the plant site prior to incorporation in the mixture.

Gradation of the finished mixture as obtained from extracted samples shall be as follows:

U.S. Sieve	Percent Passing (By Dry Weight)
1/2''	100
3/8''	90 to 100
No. 4	20 to 50
No. 10	0 to 15
No. 200	0 to 6

504.04 ASPHALT CEMENT. Asphalt cement shall conform to Section 1002.

The type material used shall be asphalt cement Grade AC-40 containing an anti-stripping additive, added at the approximate rate of 0.5 percent by weight of asphalt cement and thoroughly mixed as described in Subsection 501.03. The anti-stripping additive shall be approved by the Department and listed on the Qualified Products List prior to use.

502.05 WEATHER LIMITATIONS. Weather limitations shall be as prescribed in Subsection 501.13 with the following amendments. The placing of friction course shall be discontinued when the base temperature falls below 60°F and shall not be resumed until the base temperature reaches 60°F. If friction course is placed during the months of November, December, January and February, final acceptance of the project will not be made until after the following May 1st and the contractor will be required to satisfactorily maintain the friction course until final acceptance is made.

502.06 EQUIPMENT. Equipment shall conform to Subsections 501.05, 501.08, 501.09 and 501.10 with the following amendments.

Pavers: The pavers used shall be conventional self-powered spreading and finishing machines equipped with automatic screed and slope control devices.

Rollers: The rolling equipment used shall be the 10-ton, steel-wheel, self-propelled tandem roller. Other types of rolling equipment may be approved by the Department provided satisfactory results are achieved.

502.07 CONDITIONING OF EXISTING SURFACE. These requirements shall be as prescribed in Subsection 501.14.

502.08 TACK COAT. Tack coat conforming to Section 503 shall be uniformly applied at the rate specified by the engineer, but not to exceed 0.1 gallon per square yard. The contractor will be responsible for protection of the tack coat prior to placement of friction course, and any retacking required shall be done at no extra cost.

Unless a pay item for tack coat is provided for in the contract, tack coat will not be paid for directly but will be considered incidental to the ACFC bid item.

502.09 PREPARATION OF ASPHALT AND AGGREGATES. The asphalt cement shall be heated to the temperature specified in the job mix formula in a manner that will avoid local overheating and provide a continuous supply of asphalt to the mixer at a uniform temperature.

Aggregates shall be dried and heated to the required temperature. Burners used for drying shall be properly adjusted to avoid contamination with soot or oil. Aggregates thus contaminated will be rejected.

Aggregates shall be mixed with asphalt cement to produce a mixture that does not exceed 280°F. During cool weather, this temperature may be increased to 300°F to allow for proper compaction. Mixing of asphalt and aggregates shall continue until aggregates are thoroughly coated with asphalt. Suitable locking means shall be provided for regulation of mixing time.

502.10 HAULING, SPREADING AND FINISHING. Spreading and finishing shall be as prescribed in Subsection 501.17 with the following amendments.

The temperature of the mixture at time of placement on the surface shall be not less than 200°F. The friction course shall be transported and placed with a minimum of separation of asphalt and aggregates. The contractor is cautioned that long hauls, particularly those in excess of 40 miles, may result in separation and consequent rejection by the engineer.

The spreading and finishing machines, equipped with approved automatic screed and slope control devices, shall work with the 30-foot traveling stringline.

Longitudinal joints shall be at the centerline of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than two lanes. Transverse joints shall be in accordance with Subsection 501.15.

502.11 COMPACTION. Immediately after placement, friction course shall be uniformly compacted to the satisfaction of the engineer with a tandem steel-wheel roller of such weight as to accomplish acceptable density without excessive breakage of the aggregate.

502.12 PROTECTION OF PAVEMENT. Sections of newly finished friction course shall be protected from traffic until it has sufficiently hardened.

502.13 SURFACE TOLERANCES. Due to the composition and nature of friction course, no fixed surface tolerances will be established; however, the mixture shall be placed by approved methods that will provide uniform thickness of the friction course layer.

502.14 ACCEPTANCE. Acceptance testing for aggregate gradation will be conducted by Department personnel by obtaining a minimum of two samples from each lot of mixture produced. A lot will be considered as one day's production of a given mixture. One sample will be taken during the first half of the workday and another during the second half using random sampling techniques described in the Department's Materials Sampling Manual. Each sample will be tested in accordance with DOTD Designations: TR 308 and TR 309. Test results will be available for the contractor's use at the convenience of the Department.

When the average of the test results obtained for acceptance for each lot is outside the control limits for aggregate gradation given in Table I of Subsection 502.02, an adjustment in unit price for the lot will be made as further outlined in Subsection 502.16. This adjustment in unit price is determined by percent deviation from control limits for the No. 4 and No. 10 sieves, and only the sieve with the greatest adjustment in contract unit price will be used in assessing the penalty. When the lot is represented by two sieve analysis tests, deviation of gradation will be calculated for each test and the two deviations will be averaged for determination of adjustment in unit price as given in Subsection 502.16.

The dimensions shown on the plans are minimum values to be checked by the project personnel.

502.15 METHOD OF MEASUREMENT. The quantities for payment will be the design quantities specified in the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

The design areas of asphaltic concrete friction course are based on the horizontal dimensions shown on the plans.

Unless otherwise provided, all tack coat required will not be measured for separate payment, but will be considered incidental to the ACFC pay item.

502.16 BASIS OF PAYMENT. The accepted quantity of asphaltic concrete friction course will be paid for at the contract unit price per square yard subject to the following provisions.

If the mix does not conform to the acceptance requirements in Subsection 502.14, payment will be made at an adjusted unit price per unit of measurement of friction course.

The mix is to be accepted based on one or two gradation test deviations from the job mix formula as shown below:

Contract Price Adjustment for Gradation Deviations From Control Limits for Extracted Aggregate

	U.S. Sieve		Percent of Contract Unit Price/Lot
	No. 4	No. 10	
A	Average of deviations of two tests		
	0 to 1.0	0 to 1.0	100% payment
	1.1 to 4.0	1.1 to 3.0	98% payment
	More than 4.0	More than 3.0	95% payment
B	Deviation for one test		
	0 to 2.0	0 to 2.0	100% payment
	2.1 to 5.0	2.1 to 4.0	98% payment
	More than 5.0	More than 4.0	95% payment

In addition to the foregoing price adjustments, payment will be further subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
502(1)	Asphaltic Concrete Friction Course (Type ____)	Square Yard

Section 503

Tack Coat

503.01 DESCRIPTION. This work consists of preparing and treating an existing asphaltic or concrete surface with asphaltic material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the engineer.

503.02 ASPHALTIC MATERIAL. The tack coat shall be either cutback asphalt, Grade RC-70 or RC-250, or emulsified asphalt, Grade SS-1h or SS-1 and shall conform to Section 1002.

503.03 EQUIPMENT. The contractor shall provide equipment for heating and applying the asphaltic material and for the proper preparation of the surface to be treated. The equipment shall meet the requirements of Subsection 501.10.

503.04 PREPARATION OF SURFACE. The existing surface shall be cleaned by sweeping or by other approved methods. Edges of existing pavements adjacent to new pavement shall be cleaned to permit adhesion of the asphalt.

503.05 APPLICATION OF ASPHALT. The asphalt shall be uniformly applied with a pressure distributor at a rate not to exceed 0.05 gallon per square yard. The tack coat shall not be applied on a wet surface or when the temperature is below 40°F. The rate of application, temperature of the asphalt and areas to be treated shall be approved prior to application. The tack coat shall be applied in such a manner as to offer the least inconvenience to traffic.

503.06 METHOD OF MEASUREMENT. When a pay item for tack coat is included in the contract, the tack coat placed and accepted will be measured in the distributor by the gallon of 231 cubic inches. Measurement shall be converted to gallonage at 60°F in accordance with Section 506.

503.07 BASIS OF PAYMENT. When a pay item for tack coat is included in the contract, the accepted quantity of tack coat will be paid for at the contract unit price per gallon, subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

When the contract does not contain a pay item for tack coat, the required work will not be paid for directly, but will be considered as a subsidiary obli-

gation of the contractor under other contract items.

Payment will be made under:

Item No.	Pay Item	Pay Unit
503(1)	Tack Coat	Gallon

Section 504

Prime Coat

504.01 DESCRIPTION. This work consists of treating a prepared or existing surface with asphalt in accordance with these specifications and in reasonably close conformity with lines shown on the plans or established by the engineer.

504.02 ASPHALT MATERIAL. The asphalt used as a prime coat shall be Grade MC-30 or Grade MC-70 cutback asphalt, as directed. Cutback asphalt used as a prime coat shall conform to Section 1002.

504.03 WEATHER LIMITATIONS. Asphaltic materials shall not be applied on a wet base nor when the temperature of the air is less than 60°F in the shade.

504.04 EQUIPMENT. The contractor shall provide equipment for heating and applying the asphaltic material. The equipment shall meet the requirements of Subsection 505.05.

504.05 PREPARATION OF SURFACE. The surface to be primed shall be shaped to the required grade and section, shall be free from all ruts, corrugations, segregated material or other irregularities and shall be compacted to the required density.

Delays in priming will necessitate reprocessing or reshaping to provide a smooth compacted surface.

504.06 APPLICATION OF ASPHALT. The primer shall be applied to the prepared base and shall extend 6 inches beyond the width of surfacing shown on the plans. The prime coat shall not be applied until the base has been satisfactorily compacted and bonded, and then only when the surface has been properly swept and is firm, compact and dry. The method of application shall be the same as provided under Subsection 505.07. If the course is to be constructed on an existing pavement, the pavement shall be primed if so indicated on the plans or directed.

When the prepared base consists of cement or lime treated or stabilized material and where the protective coating or emulsified asphalt has become worn or is otherwise insufficient, the contractor will be required to spot-prime the base course as directed or the prime coat may be reduced or deleted.

The prime coat shall be maintained intact and if required, the primed sur-

face shall be thoroughly cleaned prior to the application of the wearing surface.

Where the prime coat has failed or depressions have occurred, the failure shall be swept clean, brushcoated with cutback asphalt and refilled with a satisfactory asphaltic mixture. If the prime coat is generally unsatisfactory, the contractor shall be required to reprime the unsatisfactory surface.

The prime coat shall be applied at the rates and temperatures shown in Table I. Quantities of prime coat shall not vary from that shown in Table I by more than 5 percent, unless otherwise provided herein.

TABLE I

PRIME COATS

Asphalt Grade	Application (Gal. @ 60°F per Sq. Yd.)		Temperature of Application	
	Min.	Max.	Min.	Max.
MC-30	0.25	0.3	60°F	120°F
MC-70	0.25	0.3	100°F	180°F

The volume of asphalt shall be corrected as described in Section 506.

504.07 PROTECTION. After the prime coat has been applied, unless it is impractical to detour highway traffic, the contractor shall keep all traffic off the road until the asphalt has properly cured.

In cases where traffic is permitted, the contractor may be required, at his expense, to spread the minimum necessary amount of granular material approved by the Project Engineer over the prime coat.

504.08 METHOD OF MEASUREMENT. The number of gallons of asphaltic primer placed and accepted will be measured by the gallon of 231 cubic inches and shall be measured in the distributor. Measurement shall be converted to gallonage at 60°F in accordance with Section 506.

504.09 BASIS OF PAYMENT. The accepted quantities of prime coat will be paid for at the contract unit price per gallon complete in place, except as follows.

When the contract does not contain a pay item for prime coat, the required work will not be paid for directly, but will be considered as a subsidiary obligation of the contractor under other contract items.

If the asphalt does not conform to the specifications, then the final test results for the asphalt taken at the point of delivery will be applied to the appropriate schedule of Section 1002 for price adjustment, and any adjustment in unit price shall be made as specified. If the test results are such that a penalty

would result from more than one of the test values, only the price adjustment for the greatest reduction will apply.

Payment will be made under:

Item No.	Pay Item	Pay Unit
504(1)	Prime Coat	Gallon

Section 505

Asphaltic Surface Treatment

505.01 DESCRIPTION. This work consists of furnishing and constructing a wearing surface of mineral aggregate and asphalt on a prepared base course or on an existing pavement, in accordance with these specifications and in reasonably close conformity with the lines, grades and typical cross sections shown on the plans or established by the engineer.

Asphaltic surface treatment shall consist of the number of applications of each of the specified sizes of mineral aggregate and the specified asphalt.

505.02 ASPHALT MATERIAL. The asphalt shall be asphalt cement, Grade AC-5 or AC-10, conforming to Section 1002.

505.03 AGGREGATES. Aggregates shall be uncrushed gravel, expanded clay aggregate or crushed gravel, crushed slag or crushed stone, and shall conform to Subsection 1003.06.

505.04 WEATHER LIMITATIONS. Asphalt shall not be applied on a wet base nor when the temperature of the air is less than 60°F in the shade.

Asphalt shall not be applied during the calendar months of November, December, January and February, unless otherwise approved in writing by the Chief Engineer. When approved, one of the following additional requirements shall be met during these referenced months.

(a) All aggregates to be spread shall be mechanically dried and placed in a surface dry condition. The project may then be accepted when all work is complete.

(b) If asphalt is placed during the above referenced months without mechanically drying aggregates the contractor shall be responsible for the project, and the final inspection will not be made until such time after March 1st equal to the time that was actually required to place the surface treatment.

505.05 EQUIPMENT. All equipment for the proper construction of this work shall be in good working condition and shall have been approved before construction begins. The equipment shall be maintained in a satisfactory working condition.

The equipment used by the contractor shall consist of the following units:

(a) A piece of 2 inch diamond mesh chain link fence approximately 10 feet by 15 feet shall be used for dragging operation or broom dragging equipment capable of covering ⅓ to ½ the width of the treatment.

(b) Power distributor conforming to Subsection 501.10.

(c) Power rollers shall be self-propelled steel wheel rollers or self-propelled pneumatic tire rollers.

The steel wheel rollers may be three wheel type, but tandem type is preferred. The weight of rollers shall not be less than 5 tons nor more than 10 tons.

Pneumatic rollers shall be self-propelled with wheels mounted on 2 axles in such a manner that the rear tires will not follow in the tracks of the forward group. The rollers shall be capable of applying a minimum of 50 psi contact or ground pressure under each tire and shall be of such weight that no damage is caused to the base course or surface treatment.

(d) Power revolving broom or a power blower.

(e) The spreader required shall be an approved self-propelled, pneumatic-tired power spreader, so designed, equipped and operated that the aggregate will be spread uniformly at the designated rate with the application being defined at the edges, or other equipment approved by the engineer.

All storage tanks, piping, retorts, booster tanks, distributors and other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition at all times and shall be operated in such manner as to avoid any possible contamination of the contents with foreign materials.

505.06 QUANTITIES OF MATERIAL. The quantities of materials per square yard, application temperatures and the sequence of application and spreading for the asphaltic surfacing as specified shall be as shown in Table I, unless otherwise directed.

The quantities shown in Table I are approximate. The actual quantities used shall be as directed by the engineer. Any aggregates spread in excess of 5 percent over the quantity specified by the engineer, per square yard, will not be considered for payment on a cubic yard basis.

The quantities of asphalt per square yard of treated surface as shown in Table I are based on a temperature of 60°F. All volumetric measurements shall be converted to this temperature in accordance with Section 506.

505.07 APPLICATION OF ASPHALT. After the prime coat, when required, has been satisfactorily cured, asphalt and aggregate shall be applied in the amounts and in the sequence herein specified.

The length of spread of the asphalt shall not exceed that which can be covered immediately with the aggregate material.

TABLE I
QUANTITIES OF MATERIAL PER SQUARE YARD

	Gal. of Asphalt at 60°F	Cubic Yards of Aggregate		
	Asphalt Cement	Size 1 Coarse	Size 2 Fine	Size 3 Seal
First Application	0.4			
Spreading		.0200		
Second Application	0.3			
Spreading			.0111	
Third Application	0.2			
Spreading				.0075
Totals	0.9	.0200	.0111	.0075

Temperature of Application	Minimum	Maximum
Asphalt Cement AC-5 or AC-10	275°F	350°F

Asphalt for each application shall be applied uniformly for the full width of the treatment unless, due to the impracticability of detouring highway traffic, the engineer directs that the material be applied to ½ of the roadway at one time. If the contractor is unable to keep the application of asphalt consistently within 5 percent of the quantity specified, he shall discontinue operations until he can provide an operator of greater experience or a better distributor, or both, or shall provide such precautions as may be necessary to keep the application within the available variations.

If one or more nozzles should become blocked during the application of the asphalt, the distributor shall be stopped immediately and the nozzle or nozzles cleaned out. When the engineer directs that application be made over ½ width of the roadway at one time, all nozzles, except the one towards the outside of the roadway, shall have the same size opening; and care shall be taken to see that there is a slight longitudinal overlapping of the 2 applications along the centerline of the road. The distributor shall be operated along a marked edge in order to keep the surface treatment in a straight line.

In order to secure uniform distribution at the junction of 2 applications, the distributor shall be promptly stopped when the uniform flow decreases, indicating the tank is nearly empty. Building paper shall be placed over the end of the previous application, and the joining application shall start on the building paper. The building paper so used shall be removed and disposed of in a satisfactory manner; however, burning of the building paper will not be

permitted on areas that have been recently seeded or sodded, or on any other grassy area within the limits of the right-of-way.

During the application of asphalt, care shall be taken to prevent spattering adjacent pavements, structures and trees. The distributor shall not be cleaned or discharged into ditches, borrow pits, on the shoulders or along the right-of-way.

Any excess of asphalt at the junction between distributor loads shall be removed and corrected in a satisfactory manner, and any parts of the surface to be treated which are not covered with asphalt directly from the distributor shall be covered by means of a hand hose equipped with nozzles or by hand pouring pot.

The contractor is cautioned to exercise care in heating asphalt to temperatures above flash points for the various types of asphalt.

505.08 SPREADING COVER MATERIAL. The aggregate material shall be uniformly spread over the full width of asphalt material with one or more passes of spreading equipment with the application being sharply defined at the edges. The equipment shall not be driven on the uncovered asphalt. If necessary to obtain uniform coverage, the surface shall be dragged or broomed.

Hand spreading by experienced workmen will be permitted in conjunction with the self-propelled spreaders over areas inaccessible to the spreaders.

505.09 ROLLING COVER MATERIAL. Immediately after spreading and brooming or dragging the cover material, the entire surface shall be rolled with a power roller. Rolling shall proceed in a longitudinal direction, beginning at the outer edges of the treatment and progressing toward the center, each trip overlapping the prior trip about ½ the width of the roller. The first rolling shall be completed within ½ hour after the cover material has been spread. During rolling, the previously spread cover material shall be uniformly broomed or dragged and placed where necessary in such quantity as to completely cover the asphalt surface. Rolling, dragging or brooming and spotting of additional cover material shall be continued until uniform coverage has been obtained. The remaining courses shall be rolled the same as specified for the first course and shall not be placed until the previous course is surface dry.

505.10 PROTECTION. Traffic shall not be allowed to use the road, unless otherwise provided, until the final application has been placed and thoroughly rolled.

After the application of the cover coat material, the surface where directed shall be lightly broomed or otherwise maintained for a period of 4 days or as directed. Maintenance of the surface shall include the distribution of cover coat material over the surface to absorb any free asphalt, covering any area deficient in cover coat material, and an additional rolling as directed by the

engineer at no additional cost to the Department. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept from the entire surface by means of rotary brooms. The surface shall be swept at the time determined by the engineer.

505.11 METHOD OF MEASUREMENT. The quantities of aggregate and asphalt incorporated in the completed and accepted asphaltic surface treatment will be measured separately. Aggregate will be measured by the cubic yard and asphalt will be measured by the gallon.

The number of cubic yards of aggregate placed and accepted will be determined by measurement in vehicles in accordance with Subsection 109.01 at the point of placing on the road.

The number of gallons of asphalt placed and accepted will be measured in the distributor by the gallon of 231 cubic inches and converted to gallonage at 60°F in accordance with Section 506.

505.12 BASIS OF PAYMENT. The accepted quantities of asphalt and aggregates will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
505(1)	Asphalt	Gallon
505(2)	Coarse Aggregate (Size 1)	Cubic Yard
505(3)	Fine Aggregate (Size 2)	Cubic Yard
505(4)	Seal Coat Aggregate (Size 3)	Cubic Yard

Section 506

Temperature-Volume Corrections For Asphaltic Materials

506.01 DESCRIPTION. This Section describes the method of converting volume measurements of asphalts at field temperatures to corresponding volumes at 60°F.

506.02 METHOD OF MEASUREMENT. The number of gallons of asphalt cement, cutback asphalt, or emulsified asphalt placed and accepted shall be measured in the distributor by the gallon of 231 cubic inches and the temperature observed. The measurement shall be converted to gallonage at 60°F in accordance with the applicable table.

506.03 ASPHALTIC MATERIALS. Volume conversions for asphaltic materials shall be made as follows.

Materials	Applicable Conversion Table
RC or MC Cutback Asphalts	Table I
Asphalt Cements	Table II
Emulsified Asphalts	Table III

506.04 USE OF CONVERSION TABLES. The measured volume shall be corrected to gallonage at 60°F by multiplying it by the correction factor (M) corresponding to the observed temperature (t).

Table I

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

Group 1 — Specific Gravity at 60°F of 0.850 to 0.966
Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
0	1.0241	6	1.0217	12	1.0193	18	1.0168	24	1.0144
1	1.0237	7	1.0213	13	1.0189	19	1.0164	25	1.0140
2	1.0233	8	1.0209	14	1.0185	20	1.0160	26	1.0136
3	1.0229	9	1.0205	15	1.0181	21	1.0156	27	1.0132
4	1.0225	10	1.0201	16	1.0177	22	1.0152	28	1.0128
5	1.0221	11	1.0197	17	1.0173	23	1.0148	29	1.0124

Table I (Continued)

Group 1 — Specific Gravity at 60°F of 0.850 to 0.966
Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
30	1.0120	77	0.9932	124	0.9748	171	0.9566	218	0.9388
31	1.0116	78	0.9929	125	0.9744	172	0.9562	219	0.9384
32	1.0112	79	0.9925	126	0.9740	173	0.9559	220	0.9380
33	1.0108	80	0.9921	127	0.9736	174	0.9555	221	0.9376
34	1.0104	81	0.9917	128	0.9732	175	0.9551	222	0.9373
35	1.0100	82	0.9913	129	0.9728	176	0.9547	223	0.9369
36	1.0096	83	0.9909	130	0.9725	177	0.9543	224	0.9365
37	1.0092	84	0.9905	131	0.9721	178	0.9539	225	0.9361
38	1.0088	85	0.9901	132	0.9717	179	0.9536	226	0.9358
39	1.0084	86	0.9897	133	0.9713	180	0.9532	227	0.9354
40	1.0080	87	0.9893	134	0.9709	181	0.9528	228	0.9350
41	1.0076	88	0.9889	135	0.9705	182	0.9524	229	0.9346
42	1.0072	89	0.9885	136	0.9701	183	0.9520	230	0.9343
43	1.0068	90	0.9881	137	0.9697	184	0.9517	231	0.9339
44	1.0064	91	0.9877	138	0.9693	185	0.9513	232	0.9335
45	1.0060	92	0.9873	139	0.9690	186	0.9509	233	0.9331
46	1.0056	93	0.9869	140	0.9686	187	0.9505	234	0.9328
47	1.0052	94	0.9865	141	0.9682	188	0.9501	235	0.9324
48	1.0048	95	0.9861	142	0.9678	189	0.9498	236	0.9320
49	1.0044	96	0.9857	143	0.9674	190	0.9494	237	0.9316
50	1.0040	97	0.9854	144	0.9670	191	0.9490	238	0.9313
51	1.0036	98	0.9850	145	0.9666	192	0.9486	239	0.9309
52	1.0032	99	0.9846	146	0.9662	193	0.9482	240	0.9305
53	1.0028	100	0.9842	147	0.9659	194	0.9478	241	0.9301
54	1.0024	101	0.9838	148	0.9655	195	0.9475	242	0.9298
55	1.0020	102	0.9834	149	0.9651	196	0.9471	243	0.9294
56	1.0016	103	0.9830	150	0.9647	197	0.9467	244	0.9290
57	1.0012	104	0.9826	151	0.9643	198	0.9463	245	0.9286
58	1.0008	105	0.9822	152	0.9639	199	0.9460	246	0.9283
59	1.0004	106	0.9818	153	0.9635	200	0.9456	247	0.9279
60	1.0000	107	0.9814	154	0.9632	201	0.9452	248	0.9275
61	0.9996	108	0.9810	155	0.9628	202	0.9448	249	0.9272
62	0.9992	109	0.9806	156	0.9624	203	0.9444	250	0.9268
63	0.9988	110	0.9803	157	0.9620	204	0.9441	251	0.9264
64	0.9984	111	0.9799	158	0.9616	205	0.9437	252	0.9260
65	0.9980	112	0.9795	159	0.9612	206	0.9433	253	0.9257
66	0.9976	113	0.9791	160	0.9609	207	0.9429	254	0.9253
67	0.9972	114	0.9787	161	0.9605	208	0.9425	255	0.9249
68	0.9968	115	0.9783	162	0.9601	209	0.9422	256	0.9245
69	0.9964	116	0.9779	163	0.9597	210	0.9418	257	0.9242
70	0.9960	117	0.9775	164	0.9593	211	0.9414	258	0.9238
71	0.9956	118	0.9771	165	0.9589	212	0.9410	259	0.9234
72	0.9952	119	0.9767	166	0.9585	213	0.9407	260	0.9231
73	0.9948	120	0.9763	167	0.9582	214	0.9403	261	0.9227
74	0.9944	121	0.9760	168	0.9578	215	0.9399	262	0.9223
75	0.9940	122	0.9756	169	0.9574	216	0.9395	263	0.9219
76	0.9936	123	0.9752	170	0.9570	217	0.9391	264	0.9216

Table I (Continued)

Group 1 — Specific Gravity at 60°F of 0.850 to 0.966
Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
265	0.9212	312	0.9039	359	0.8870	406	0.8703	453	0.8540
266	0.9208	313	0.9036	360	0.8866	407	0.8700	454	0.8536
267	0.9205	314	0.9032	361	0.8863	408	0.8696	455	0.8533
268	0.9201	315	0.9029	362	0.8859	409	0.8693	456	0.8529
269	0.9197	316	0.9025	363	0.8856	410	0.8689	457	0.8526
270	0.9194	317	0.9021	364	0.8852	411	0.8686	458	0.8522
271	0.9190	318	0.9018	365	0.8848	412	0.8682	459	0.8519
272	0.9186	319	0.9014	366	0.8845	413	0.8679	460	0.8516
273	0.9182	320	0.9010	367	0.8841	414	0.8675	461	0.8512
274	0.9179	321	0.9007	368	0.8838	415	0.8672	462	0.8509
275	0.9175	322	0.9003	369	0.8834	416	0.8668	463	0.8505
276	0.9171	323	0.9000	370	0.8831	417	0.8665	464	0.8502
277	0.9168	324	0.8996	371	0.8827	418	0.8661	465	0.8498
278	0.9164	325	0.8992	372	0.8823	419	0.8658	466	0.8495
279	0.9160	326	0.8989	373	0.8820	420	0.8654	467	0.8492
280	0.9157	327	0.8985	374	0.8816	421	0.8651	468	0.8488
281	0.9153	328	0.8981	375	0.8813	422	0.8647	469	0.8485
282	0.9149	329	0.8978	376	0.8809	423	0.8644	470	0.8481
283	0.9146	330	0.8974	377	0.8806	424	0.8640	471	0.8478
284	0.9142	331	0.8971	378	0.8802	425	0.8637	472	0.8474
285	0.9138	332	0.8967	379	0.8799	426	0.8633	473	0.8471
286	0.9135	333	0.8963	380	0.8795	427	0.8630	474	0.8468
287	0.9131	334	0.8960	381	0.8792	428	0.8626	475	0.8464
288	0.9127	335	0.8956	382	0.8788	429	0.8623	476	0.8461
289	0.9124	336	0.8952	383	0.8784	430	0.8619	477	0.8457
290	0.9120	337	0.8949	384	0.8781	431	0.8616	478	0.8454
291	0.9116	338	0.8945	385	0.8777	432	0.8612	479	0.8451
292	0.9113	339	0.8942	386	0.8774	433	0.8609	480	0.8447
293	0.9109	340	0.8938	387	0.8770	434	0.8605	481	0.8444
294	0.9105	341	0.8934	388	0.8767	435	0.8602	482	0.8440
295	0.9102	342	0.8931	389	0.8763	436	0.8599	483	0.8437
296	0.9098	343	0.8927	390	0.8760	437	0.8595	484	0.8433
297	0.9094	344	0.8924	391	0.8756	438	0.8592	485	0.8430
298	0.9091	345	0.8920	392	0.8753	439	0.8588	486	0.8427
299	0.9087	346	0.8916	393	0.8749	440	0.8585	487	0.8423
300	0.9083	347	0.8913	394	0.8746	441	0.8581	488	0.8420
301	0.9080	348	0.8909	395	0.8742	442	0.8578	489	0.8416
302	0.9076	349	0.8906	396	0.8738	443	0.8574	490	0.8413
303	0.9072	350	0.8902	397	0.8735	444	0.8571	491	0.8410
304	0.9069	351	0.8899	398	0.8731	445	0.8567	492	0.8406
305	0.9065	352	0.8895	399	0.8728	446	0.8564	493	0.8403
306	0.9061	353	0.8891	400	0.8724	447	0.8560	494	0.8399
307	0.9058	354	0.8888	401	0.8721	448	0.8557	495	0.8396
308	0.9054	355	0.8884	402	0.8717	449	0.8554	496	0.8393
309	0.9050	356	0.8881	403	0.8714	450	0.8550	497	0.8389
310	0.9047	357	0.8877	404	0.8710	451	0.8547	498	0.8386
311	0.9043	358	0.8873	405	0.8707	452	0.8543	499	0.8383

Table II

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIAL

Group 0 — Specific Gravity at 60°F above 0.966

Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
0	1.0211	45	1.0053	90	0.9896	135	0.9740	180	0.9587
1	1.0208	46	1.0049	91	0.9892	136	0.9737	181	0.9584
2	1.0204	47	1.0046	92	0.9889	137	0.9734	182	0.9580
3	1.0201	48	1.0042	93	0.9885	138	0.9730	183	0.9577
4	1.0197	49	1.0038	94	0.9882	139	0.9727	184	0.9574
5	1.0194	50	1.0035	95	0.9878	140	0.9723	185	0.9570
6	1.0190	51	1.0031	96	0.9875	141	0.9720	186	0.9567
7	1.0186	52	1.0028	97	0.9871	142	0.9716	187	0.9563
8	1.0183	53	1.0024	98	0.9868	143	0.9713	188	0.9560
9	1.0179	54	1.0021	99	0.9864	144	0.9710	189	0.9557
10	1.0176	55	1.0017	100	0.9861	145	0.9706	190	0.9553
11	1.0172	56	1.0014	101	0.9857	146	0.9703	191	0.9550
12	1.0169	57	1.0010	102	0.9854	147	0.9699	192	0.9547
13	1.0165	58	1.0007	103	0.9851	148	0.9696	193	0.9548
14	1.0162	59	1.0003	104	0.9847	149	0.9693	194	0.9540
15	1.0158	60	1.0000	105	0.9844	150	0.9689	195	0.9536
16	1.0155	61	0.9997	106	0.9840	151	0.9686	196	0.9533
17	1.0151	62	0.9993	107	0.9837	152	0.9682	197	0.9530
18	1.0148	63	0.9990	108	0.9833	153	0.9679	198	0.9526
19	1.0144	64	0.9986	109	0.9830	154	0.9675	199	0.9523
20	1.0141	65	0.9983	110	0.9826	155	0.9672	200	0.9520
21	1.0137	66	0.9979	111	0.9823	156	0.9669	201	0.9516
22	1.0133	67	0.9976	112	0.9819	157	0.9665	202	0.9513
23	1.0130	68	0.9972	113	0.9816	158	0.9662	203	0.9509
24	1.0126	69	0.9969	114	0.9813	159	0.9658	204	0.9506
25	1.0123	70	0.9965	115	0.9809	160	0.9655	205	0.9503
26	1.0119	71	0.9962	116	0.9806	161	0.9652	206	0.9499
27	1.0116	72	0.9958	117	0.9802	162	0.9648	207	0.9496
28	1.0112	73	0.9955	118	0.9799	163	0.9645	208	0.9493
29	1.0109	74	0.9951	119	0.9795	164	0.9641	209	0.9489
30	1.0105	75	0.9948	120	0.9792	165	0.9638	210	0.9486
31	1.0102	76	0.9944	121	0.9788	166	0.9635	211	0.9483
32	1.0098	77	0.9941	122	0.9785	167	0.9631	212	0.9479
33	1.0095	78	0.9937	123	0.9782	168	0.9628	213	0.9476
34	1.0091	79	0.9934	124	0.9778	169	0.9624	214	0.9472
35	1.0088	80	0.9930	125	0.9775	170	0.9621	215	0.9469
36	1.0084	81	0.9927	126	0.9771	171	0.9618	216	0.9466
37	1.0081	82	0.9923	127	0.9768	172	0.9614	217	0.9462
38	1.0077	83	0.9920	128	0.9764	173	0.9611	218	0.9459
39	1.0074	84	0.9916	129	0.9761	174	0.9607	219	0.9456
40	1.0070	85	0.9913	130	0.9758	175	0.9604	220	0.9452
41	1.0067	86	0.9909	131	0.9754	176	0.9601	221	0.9449
42	1.0063	87	0.9906	132	0.9751	177	0.9597	222	0.9446
43	1.0060	88	0.9902	133	0.9747	178	0.9594	223	0.9442
44	1.0056	89	0.9899	134	0.9744	179	0.9590	224	0.9439

Table II (Continued)

Group **0** — Specific Gravity at 60°F above 0.966

Legend: **t** = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
225	0.9436	**273**	0.9276	**321**	0.9118	**369**	0.8963	**417**	0.8810
226	0.9432	**274**	0.9273	**322**	0.9115	**370**	0.8960	**418**	0.8806
227	0.9429	**275**	0.9269	**323**	0.9112	**371**	0.8957	**419**	0.8803
228	0.9426	**276**	0.9266	**324**	0.9109	**372**	0.8953	**420**	0.8800
229	0.9422	**277**	0.9263	**325**	0.9105	**373**	0.8950	**421**	0.8797
230	0.9419	**278**	0.9259	**326**	0.9102	**374**	0.8947	**422**	0.8794
231	0.9416	**279**	0.9256	**327**	0.9099	**375**	0.8944	**423**	0.8791
232	0.9412	**280**	0.9253	**328**	0.9096	**376**	0.8941	**424**	0.8787
233	0.9409	**281**	0.9250	**329**	0.9092	**377**	0.8937	**425**	0.8784
234	0.9405	**282**	0.9246	**330**	0.9089	**378**	0.8934	**426**	0.8781
235	0.9402	**283**	0.9243	**331**	0.9086	**379**	0.8931	**427**	0.8778
236	0.9399	**284**	0.9240	**332**	0.9083	**380**	0.8928	**428**	0.8775
237	0.9395	**285**	0.9236	**333**	0.9079	**381**	0.8924	**429**	0.8772
238	0.9392	**286**	0.9233	**334**	0.9076	**382**	0.8921	**430**	0.8768
239	0.9389	**287**	0.9230	**335**	0.9073	**383**	0.8918	**431**	0.8765
240	0.9385	**288**	0.9227	**336**	0.9070	**384**	0.8915	**432**	0.8762
241	0.9382	**289**	0.9223	**337**	0.9066	**385**	0.8912	**433**	0.8759
242	0.9379	**290**	0.9220	**338**	0.9063	**386**	0.8908	**434**	0.8756
243	0.9375	**291**	0.9217	**339**	0.9060	**387**	0.8905	**435**	0.8753
244	0.9372	**292**	0.9213	**340**	0.9057	**388**	0.8902	**436**	0.8749
245	0.9369	**293**	0.9210	**341**	0.9053	**389**	0.8899	**437**	0.8746
246	0.9365	**294**	0.9207	**342**	0.9050	**390**	0.8896	**438**	0.8743
247	0.9362	**295**	0.9204	**343**	0.9047	**391**	0.8892	**439**	0.8740
248	0.9359	**296**	0.9200	**344**	0.9044	**392**	0.8889	**440**	0.8737
249	0.9356	**297**	0.9197	**345**	0.9040	**393**	0.8886	**441**	0.8734
250	0.9352	**298**	0.9194	**346**	0.9037	**394**	0.8883	**442**	0.8731
251	0.9349	**299**	0.9190	**347**	0.9034	**395**	0.8880	**443**	0.8727
252	0.9346	**300**	0.9187	**348**	0.9031	**396**	0.8876	**444**	0.8724
253	0.9342	**301**	0.9184	**349**	0.9028	**397**	0.8873	**445**	0.8721
254	0.9339	**302**	0.9181	**350**	0.9024	**398**	0.8870	**446**	0.8718
255	0.9336	**303**	0.9177	**351**	0.9021	**399**	0.8867	**447**	0.8715
256	0.9332	**304**	0.9174	**352**	0.9018	**400**	0.8864	**448**	0.8712
257	0.9329	**305**	0.9171	**353**	0.9015	**401**	0.8861	**449**	0.8709
258	0.9326	**306**	0.9167	**354**	0.9011	**402**	0.8857	**450**	0.8705
259	0.9322	**307**	0.9164	**355**	0.9008	**403**	0.8854	**451**	0.8702
260	0.9319	**308**	0.9161	**356**	0.9005	**404**	0.8851	**452**	0.8699
261	0.9316	**309**	0.9158	**357**	0.9002	**405**	0.8848	**453**	0.8696
262	0.9312	**310**	0.9154	**358**	0.8998	**406**	0.8845	**454**	0.8693
263	0.9309	**311**	0.9151	**359**	0.8995	**407**	0.8841	**455**	0.8690
264	0.9306	**312**	0.9148	**360**	0.8992	**408**	0.8838	**456**	0.8687
265	0.9302	**313**	0.9145	**361**	0.8989	**409**	0.8835	**457**	0.8683
266	0.9299	**314**	0.9141	**362**	0.8986	**410**	0.8832	**458**	0.8680
267	0.9296	**315**	0.9138	**363**	0.8982	**411**	0.8829	**459**	0.8677
268	0.9293	**316**	0.9135	**364**	0.8979	**412**	0.8826	**460**	0.8674
269	0.9289	**317**	0.9132	**365**	0.8976	**413**	0.8822	**461**	0.8671
270	0.9286	**318**	0.9128	**366**	0.8973	**414**	0.8819	**462**	0.8668
271	0.9283	**319**	0.9125	**367**	0.8969	**415**	0.8816	**463**	0.8665
272	0.9279	**320**	0.9122	**368**	0.8966	**416**	0.8813	**464**	0.8661

Table II (Continued)

Group O — Specific Gravity at 60°F above 0.966
Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
465	0.8658	472	0.8636	479	0.8615	486	0.8593	493	0.8571
466	0.8655	473	0.8633	480	0.8611	487	0.8590	494	0.8568
467	0.8652	474	0.8630	481	0.8608	488	0.8587	495	0.8565
468	0.8649	475	0.8627	482	0.8605	489	0.8583	496	0.8562
469	0.8646	476	0.8624	483	0.8602	490	0.8580	497	0.8559
470	0.8643	477	0.8621	484	0.8599	491	0.8577	498	0.8556
471	0.8640	478	0.8618	485	0.8596	492	0.8574	499	0.8552

Table III
TEMPERATURE-VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS

Legend: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M
60	1.00000	78	.99550	96	.99100	115	.98625	133	.98175
61	.99975	79	.99525	97	.99075	116	.98600	134	.98150
62	.99950	80	.99500	98	.99050	117	.98575	135	.98125
63	.99925	81	.99475	99	.99025	118	.98550	136	.98100
64	.99900	82	.99450	100	.99000	119	.98525	137	.98075
65	.99875	83	.99425	101	.98975	120	.98500	138	.98050
66	.99850	84	.99400	102	.98950	121	.98475	139	.98025
67	.99825	85	.99375	103	.98925	122	.98450	140	.98000
68	.99800	86	.99350	104	.98900	123	.98425	141	.97975
69	.99775	87	.99325	105	.98875	124	.98400	142	.97950
70	.99750	88	.99300	106	.98850	125	.98375	143	.97925
71	.99725	89	.99275	107	.98825	126	.98350	144	.97900
72	.99700	90	.99250	108	.98800	127	.98325	145	.97875
73	.99675	91	.99225	109	.98775	128	.98300	146	.97850
74	.99650	92	.99200	110	.98750	129	.98275	147	.97825
75	.99625	93	.99175	111	.98725	130	.98250	148	.97800
76	.99600	94	.99150	112	.98700	131	.98225	149	.97775
77	.99575	95	.99125	113	.98675	132	.98200	150	.97750
				114	.98650				

PART VI

RIGID PAVEMENT

Section 601

Portland Cement Concrete Pavement

601.01 DESCRIPTION. This work consists of constructing portland cement concrete pavement, with or without reinforcement as specified, on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

All concrete plants furnishing portland cement concrete for paving shall be certified, and the design and control of the concrete mixtures shall be the responsibility of the contractor in accordance with these specifications and the requirements of Section 901.

601.02 MATERIALS. Materials shall conform to the following Sections or Subsections.

Portland Cement Concrete	901
Joint Materials	1005
Mesh Reinforcement	1009.01
Load Transmission Devices	1009.04
Continuous Reinforcement	1009.12
Wide Flange Beam	1013.26
Curing Materials	1011.01
Cellular Polystyrene	1005.01

The contractor will be permitted to furnish either Type B, C, D or E portland cement concrete pavement; however, the same type pavement mixture shall be used throughout the project, unless otherwise authorized by the engineer in writing.

Reference is made to Subsection 901.07, Composition of Concrete, with "Master Proportion Table" for all portland cement concrete mixtures. The contractor will also be permitted to furnish Class A structural concrete in lieu of the mixtures listed above.

601.03 EQUIPMENT. Equipment and tools necessary for handling materials and performing all parts of the work must meet with the approval of the engineer as to design, capacity and mechanical condition. The equipment must be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly for approval.

(a) **Vibrators:** Vibrators for full width vibration of concrete paving slabs shall be the internal type with either immersed tube or multiple spuds. They must be attached to the spreader, the finishing machine or may be mounted on a separate carriage. The spacing of the vibrators shall not exceed 24 inches. They shall not come in contact with joints, load transfer devices, subgrade or side forms. Frequency of the internal vibrators, both tube and spud vibrators, shall be from 7,000 to 10,000 impulses per minute measured with the vibrators submerged. This frequency also applies to spud type internal vibrators, either hand-operated or attached to spreader or finishing machine, that are used adjacent to forms.

Vibrators mounted on any machine or carriage shall be so interlocked with the forward travel mechanism as to automatically start and stop vibrating as that machine starts and stops.

(b) **Concrete Saw:** When sawing joints is elected or specified, the contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions.

(c) **Forms:** Straight side forms shall be made of metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. On curves with a radius greater than 150 feet, straight forms of shorter lengths will be permitted. Forms shall have a depth not less than the specified edge thickness of the pavement and a base width at least 0.8 of the depth, except as otherwise approved by the engineer. Flexible or curved forms of proper radius shall be used on curves of 150-foot radius or less and shall be of a design acceptable to the engineer. Forms shall be provided with adequate devices for secure setting.Flange braces shall extend outward on the base not less than 2/3 the height of the forms. Forms with battered top surfaces and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. When approved by the engineer, built-up forms may be used; however, the build-up shall not exceed 2 inches. No limitation will be made on the use of built-up forms or the amount of build-up where the total area of pavement of any specified thickness on the project is less than 2,000 square yards. The top face of the form shall not vary from a true plane more than ⅛ inch in 10 feet and the upstanding leg shall not vary more than ¼ inch from the vertical. The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting.

601.04 PREPARATION OF GRADE. After the roadbed has been graded and compacted, the grade shall be trimmed approximately to correct elevation, extending the work at least 1.0 foot beyond each edge of the proposed concrete pavement and to a greater width as necessary when the slip form paving method is used.

Where the subgrade or base course is cement or lime treated (or stabilized),

asphaltic concrete or other semi-rigid construction, high places in the grade shall be cut or planed down. The base course shall be swept, broomed or otherwise cleaned of all loose or surplus material.

601.05 PLACING FORMS.

(a) Base Support: The foundation under forms shall be firm and true to grade so that the form, when set, will be firmly in contact for its whole length or firmly shimmed and at the specified grade. Imperfections or variations in grade shall be corrected as necessary.

(b) Form Setting: Forms shall be set sufficiently in advance of the point where concrete is being placed. After forms have been set to correct grade, the base or subgrade shall be thoroughly tamped, mechanically or by hand, at both inside and outside edges of forms. On asphaltic concrete base, or stabilized or treated base, each 10-foot section of forms shall be staked into place with at least 2 pins installed in full-size drilled holes. On other type base or subgrade, at least 3 pins will be required in each 10-foot section. A pin shall be placed at each side of every joint. Pins shall be sufficient length to provide adequate anchorage. Form sections shall be tightly locked, free from play or movement in any direction. Each form section shall not deviate from true line by more than ⅜ inch at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. The face and top of forms shall be cleaned and oiled prior to placing concrete.

(c) Grade and Alignment: Alignment and grade elevations of forms shall be checked and corrections made by the contractor prior to placing concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

601.06 CONDITIONING OF SUBGRADE OR BASE COURSE. The subgrade or base course shall be brought to proper cross section. High areas shall be trimmed to proper elevation. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed. No concrete shall be placed until the subgrade or base course has been approved.

The subgrade or base course shall be uniformly moist when concrete is placed. If it becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

601.07 PLACING CONCRETE. The concrete shall be deposited on the grade in such manner as to require as little rehandling as possible. All equipment shall be so designed and operated as to assure placing and spreading of concrete without segregation. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels or other approved tools, excluding rakes. Workmen shall not be allowed to walk in the freshly mixed concrete

with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated on the existing lane of pavement, that lane shall have attained a minimum age of 10 days, or the concrete shall have attained a flexural strength of 600 psi as shown by a test of standard specimens cured under the same climatic and moisture conditions as the slab in accordance with AASHTO Designation: T 97 or a compressive strength of 3,000 psi in accordance with AASHTO Designation: T 22. If only finishing equipment is carried on the existing lane, paving in adjoining lanes will be permitted after 3 days, exclusive of days when temperature is below 40°F.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from discharge bucket or hopper onto a joint assembly unless hopper is well centered on the joint assembly.

Concrete shall be thoroughly consolidated for its full width and against and along the faces of all forms and along the full length and on both sides of all joint assemblies by means of vibrators inserted in the concrete or other acceptable methods. Vibrators shall not be permitted to come in contact with a joint assembly, the subgrade or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.

601.08 TEST SPECIMENS. The contractor shall, at his expense, furnish the concrete necessary for casting test beams and cylinders as required. Test specimens will be made and cured by the method specified in DOTD Designation: TR 226.

601.09 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT. Following the placing of concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the established elevation. When reinforced concrete is placed in one layer, the reinforcing may be positioned in advance of concrete placement or it may be placed in the plastic concrete after spreading, by mechanical or vibratory means. When reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly on the concrete, after which the top layer of concrete shall be placed as quickly as possible, not to exceed 30 minutes. When, due to conditions beyond the control of the contractor, more than 30 minutes time has elapsed before the top layer of concrete is placed, but not is excess of one hour, the location by stations, the temperature and other weather conditions and any other pertinent data will be recorded on the Concrete Inspectors Daily Report. At such locations, core borings will be

taken at a later date to determine whether the slab in question is monolithic.

Any portion of the bottom layer of concrete which has been in place for more than one hour shall be removed and replaced with fresh concrete at the contractor's expense prior to placing the top layer.

When the top layer of concrete is placed after the initial 30-minute period and before the expiration of one hour and core borings indicate a monolith has not been attained, the engineer may order the concrete to be removed and replaced at the contractor's expense.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil or other organic materials that may adversely affect bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory provided the minimum dimensions and weight of a hand wire brushed test specimen are not less than the tolerance allowed.

601.10 JOINTS. Joints shall be constructed of the type and dimensions shown on the plans at the specified locations or as directed.

(a) Longitudinal Joint: The longitudinal joint shall not interrupt the continuity of any transverse joint. Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be coated with asphalt or other material or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, steel side forms or other approved methods shall be used. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before concrete of the adjacent lane is placed or, in lieu of bent tie bars, approved 2-piece connectors may be used. Tie bars which break or show evidence of fracture upon straightening shall be replaced when directed by the engineer by drilling 1 inch holes to a depth of 12 inches and pressure grouting the holes before insertion of the tie bars.

(1) The groove for the longitudinal joint shall be formed by using a "T" iron wheel or other device that will insure a groove that is true in both vertical and horizontal alignment. All grooves shall be cut to the minimum depth shown on the plans and in such manner that the surface of freshly placed concrete will not be depressed or otherwise disturbed. Retempering of concrete adjacent to joints will not be permitted.

Strips of preformed joint filler material of the dimensions shown on the plans shall be inserted in the groove. After insertion, the top edge of the strip shall be flush with the surface or slightly below. In no case shall the distance between the top of the insert and the surface of concrete exceed ⅛ inch. The joint shall then be aligned and the surface of the pavement floated and checked with a 10 foot straightedge. These fillers

shall conform to Subsection 1005.01(a)1; (a)(2), Types I or III; or (e), and no sealer is required. Filler in accordance with Subsection 1005.01(c) may be used if a sealer in accordance with Subsection 1005.02(a), (b) or (c), is used.

(2) A flexible joint forming device of the types shown on the plans may be used. Such joints shall be formed in accordance with plan details and the recommendation of the manufacturer. When the contractor desires to use a joint forming device not shown on the plans, the device and the method of installation must be approved in writing by the engineer. These joint forming devices shall conform to Subsection 1005.01(d).

(b) Transverse Expansion Joints: The expansion joint filler shall be one of the following types:

(1) Fillers requiring sealing: When wood filler conforming to Subsection 1005.01(b), cellular polystyrene conforming to Subsection 1005.01(f) or preformed nonbituminous cellular filler (for sawed joints) conforming to Subsection 1005.01(c) is used to form the joint, they shall be sealed in accordance with the plans. When wood filler is used, it shall be immersed in water for a period of not less than 24 hours before installation in the pavement. The boards shall be kept thoroughly wet until installed. The sealer shall be one of the following materials:

a. Performed elastomeric compression seal conforming to Subsection 1005.03.

b. PVC extended hot poured elastic joint sealer conforming to Subsection 1005.02(a).

c. Polyurethane sealant conforming to 1005.02(b).

(2) Fillers not requiring sealing shall conform to Subsections 1005.01(a), Type I or III, or 1005.01(c).

The expansion joint filler shall be continuous from form to form and shaped to the subgrade. Preformed joint fillers shall be furnished in lengths equal to the pavement width or equal to the width of one lane, except that when polyethylene conforming to Subsection 1005.01(e) is used, a minimum length of 9 feet is acceptable. Damaged or repaired joint fillers shall not be used unless approved by the engineer.

The load transfer device shall provide bracing adequate to hold the expansion joint filler in a vertical position. An expansion installing bar or other device shall be used if required to secure preformed expansion joint filler at proper grade and alignment during placing, vibrating and finishing of concrete. Care shall be taken to prevent indentations, deformations or punctures of the filler. Finished joints shall not deviate more than ¼ inch in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of

concrete shall be permitted within the expansion space.

(c) Transverse Contraction Joints (Dummy Joints): Transverse contraction joints shall consist of planes of weakness created in cross section of pavement and shall be constructed by one of the following methods:

(1) Install a nonbituminous preformed filler board in a groove in the pavement formed as outlined under Heading (a)(1) of this Subsection and then sawed to the dimensions specified with one pass of the saw.

(2) Install an approved removable joint forming device to form a joint to a width slightly less than the required width and to the required depth. The joint shall then be sawed to proper width and depth with one pass of the saw.

(3) Install an approved removable joint device to form a joint to the required width and depth. This device shall be vibrated and remain in place for a minimum of 72 hours before removal. These devices may be reused provided they are cleaned of foreign materials and are undamaged in removal. They shall be reused only with prior approval of the engineer.

Unless otherwise specified, the joints shall include load transfer devices.

(d) Transverse Construction Joints: Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 10 feet of an expansion joint, contraction joint or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete back to the preceding joint shall be removed and disposed of as directed. Hand vibrators shall be used to ensure proper consolidation of the concrete adjacent to the construction joint.

(e) Load Transfer Devices: Load transfer devices, either dowel assemblies or cantilever type assemblies, shall conform to Subsection 1009.04. Dowels may be held in positions parallel to the surface and centerline by a metal device that is left in the pavement.

Dowels shall be smooth, free of burrs, projections and deformations which may prevent pavement slippage. Dowels shall be coated with one coat of an approved paint and thoroughly coated with an approved lubricant to prevent concrete from bonding to the dowel. In lieu of painted and lubricated dowels, plastic coated dowel bars in accordance with Subsection 1009.04 may be used. An approved sleeve conforming to Subsection 1009.04(a) shall be furnished with each dowel bar used in expansion joints. The sleeve shall fit the dowel bar tightly and the closed end shall be watertight.

Cantilever type assemblies shall be of the type shown on the plans or approved equal.

Load transfer devices may be placed by an approved mechanical device provided satisfactory positioning and alignment is attained.

Load transfer devices for construction joints shall be the dowel assembly type.

(f) Overlaid Pavement. Where the plans provide that concrete pavement be overlaid with asphaltic concrete, the sawing and sealing of longitudinal and transverse joints will not be required.

601.11 FINAL STRIKE-OFF, CONSOLIDATION AND FINISHING.

(a) Sequence: The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straightedging and final surface finish.

In general, the addition of water to the surface of concrete to assist in finishing operations will not be permitted. If application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

During final surface finish operations, all areas that are improperly finished shall be refloated and refinished as required.

(b) Finishing at Joints:

(1) Concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around load transfer devices, joint assembly units and other features designed to extend into the pavement. Concrete adjacent to joints shall be consolidated as required in Subsection 601.07.

(2) After concrete has been placed and vibrated adjacent to joints as required in Subsection 601.07, the finishing machine shall be brought foward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine to, over and beyond the joint causes segregation of concrete, damage to, or misalignment of joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated concrete shall be removed from in front of and off the joint, the front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

(c) Machine Finishing: Vibrators for full width vibration of concrete paving slabs shall conform to Subsection 601.03(a). In no case shall vibra-

tors be operated longer than 15 seconds in one location. If uniform and satisfactory density of concrete is not obtained by the vibratory method at joints, along forms, at structures and throughout the pavement, the contractor shall furnish equipment and use methods which will produce pavement conforming to the specifications.

(d) **Hand Finishing:** Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.

Pavement widths not exceeding 16 feet or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

The screed for the surface shall be at least 2 feet longer than the maximum width of slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape and be constructed either of metal or of other suitable material shod with metal.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

In operation, the screed shall be moved forward on forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section and free from porous areas.

(e) **Floating:** After the concrete has been struck off and consolidated, it shall be further smoothed, trued and consolidated by means of a float, using one of the following methods as specified or permitted.

(1) **Longitudinal Float Method:** The mechanical longitudinal float shall be of a design approved by the engineer and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the engineer on each transverse trip. The float shall pass over each area of pavement at least 2 times, but excessive operation over a given area will not be permitted. Any excess

water or soupy material shall be wasted over the side forms on each pass.

(2) **Pan Float Method:** The contractor may use a machine composed of cutting and smoothing float or floats suspended from and guided by a rigid frame. The frame shall be carried by 4 or more visible wheels riding on, and constantly in contact with, the side forms.

If necessary, following one of the preceding methods of floating, long-handled floats having blades not less than 5 feet in length and 6 inches in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of or supplementing one of the preceding methods of floating. When strike-off and consolidation are done by hand methods and the crown of the pavement will not permit use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped ½ the length of the blade.

(f) Straightedge Testing and Surface Correction: After floating has been completed and excess water removed but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with an accurate 10-foot straightedge swung from handles approximately 3 feet longer than ½ the width of the slab. The straightedge shall be furnished and used by the contractor and shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other as necessary. Advance along the road shall be in successive stages of not more than ½ the length of the straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across the joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

(g) Final Finish and Texture: Unless otherwise specified, the final finish and texture shall be obtained by using a fabric drag in accordance with Heading (h) of this Subsection followed by a metal tine texturing device. Approved methods other than the tine finish shall be used for the final finish on crossovers, rest areas, parking areas, turnouts and driveways.

Final texturing with the metal tine shall produce grooves uniform in appearance and transverse to the centerline of the pavement and a continuously textured surface. Tines shall be approximately 0.025 x 0.126 inch

steel flat wire, 4 to 5 inches in length spaced on ½ inch centers. Grooves produced in the concrete shall be 3/16 inch in depth with a minimum depth of ⅛ inch. The metal tine device shall be operated by approved mechanical means when texturing main roadway pavement lanes. Manual methods may be used for texturing ramps, split slab construction or other pavement sections when approved by the engineer. Tine texturing shall not be used within approximately 2 inches of transverse joints.

Depth of final finish will be checked in accordance with DOTD Designation: TR 229. The texturing operations must be satisfactory to the engineer. Texturing equipment other than that specified herein may be approved for use provided it produces a texture equivalent to that produced by the specified metal tine.

(h) Drag Finish: When permitted or specified, the surface texture shall be a drag finish. The drag used shall consist of a seamless strip of damp burlap or cotton fabric which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of the pavement. For pavement 16 feet or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric at least 4 feet wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16 inch in depth. Drags that cannot be cleaned shall be discarded and new drags substituted.

(i) Belt Finish: When permitted or specified, the surface texture shall be a belt finish. When straightedging is complete and water sheen has practically disappeared and before the concrete becomes non-plastic, the surface shall be belted with a 2-ply canvas belt not less than 8 inches wide and at least 3 feet longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the centerline.

(j) Broom Finish: When permitted or specified, the surface texture shall be a broom finish. It shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and not more than 1/16 inch in depth. Brooming shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities and depressions resulting from improper handling of the broom. Brooms shall

be of such quality, size and construction and be so operated as to produce a surface finish meeting the approval of the engineer. Subject to satisfactory results being obtained, the contractor will be permitted to use mechanical brooming in lieu of manual brooming.

(k) Edging At Forms and Joints: After the final finish but before the concrete has taken its initial set, the edges of pavement along each side and each side of transverse expansion joints, formed joints and transverse construction joints shall be worked with an approved tool and rounded to the radius specified. A well-defined, continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during use.

Tool marks appearing on the slab adjacent to joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be removed.

All joints shall be tested with a straightedge before the concrete has set and correction made if one side of the joint is higher than the other or if they are higher or lower than adjacent slabs.

(l) Finish for Concrete to be Overlaid: Where new portland cement concrete pavement is to be overlaid with asphaltic concrete, final strike-off and surface finishing as hereinbefore specified will not be required and the pavement shall be finished to reasonably close conformity to the lines, grades and typical section to the satisfaction of the engineer. Machine finishing and/or hand finishing methods may be employed. The final surface finish shall be approximately equivalent to that normally achieved with a wood float.

601.12 CURING. Immediately after completion of finishing operations and as soon as marring of concrete will not occur, the entire surface of newly placed concrete shall be covered and cured with a white pigmented impervious membrane. The concrete shall not be left exposed for more than ½ hour during the curing period.

The contractor shall have available at the job site sufficient covering material to cover and properly protect the last hour's pour against the effects of rain. This covering material may be burlap mats, waterproof paper or combined burlap and white polyethylene sheeting. Failure to provide sufficient cover material or to adequately take care of curing requirements shall be cause for immediate suspension of concreting operations.

Other curing methods may be used when specified in the project specifications or approved in writing by the engineer. In all cases in which curing requires the use of water, the curing shall have prior right to all water supplies.

The required white pigmented impervious membrane curing method and

other curing methods are as follows.

(a) White Pigmented Impervious Membrane: The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after completion of surface finishing and before the concrete sets. If the pavement is cured initially with burlap mats and the mats are removed prior to expiration of 72 hours, curing compound shall be applied immediately. Curing compound shall not be applied during rainfall.

Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer but in no case less than one gallon per 100 square feet of surface area. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by mechanical or other approved means. Hand spraying of odd widths or shapes and on surfaces exposed by the removal of forms will be permitted provided curing compound has been thoroughly agitated prior to placing in the hand sprayer. Curing compound shall not be applied to the inside faces of joints to be sealed. In split slab construction, the curing compound shall be applied in such manner as to prevent spraying exposed reinforcing steel.

Should the film become damaged within the required curing period, the damaged portions shall be repaired immediately with additional compound.

Upon removal of side forms, the sides of the slabs exposed shall be protected immediately in such manner as to provide a curing treatment equal to that provided for the surface.

(b) Waterproof Paper: The surface of the pavement shall be thoroughly wet prior to placing the paper. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches. The paper shall be so placed and weighted down as to cause it to remain in contact with the surface. The paper shall have such dimensions that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement or of pavement width and 2-foot strips of paper for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not separate during the curing period. After removal of side forms, the material shall be folded down over the edges of the pavement and secured by a continuous bank of earth. The covering shall be maintained in place for 72 hours after the concrete has been placed.

(c) Burlap Mats: The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they

will extend at least twice the thickness of the pavement beyond the edges of the slab. The mats shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. After removal of side forms, the material shall be folded down over the edges of the pavement and secured by a continuous bank of earth. The mats shall be so placed and weighted down as to cause them to remain in contact with the surface, and the covering shall be maintained fully wet and in position for 72 hours after the concrete has been placed.

(d) White Polyethylene Sheeting: The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be so placed and weighted down as to cause it to remain in contact with the surface. The sheeting shall have such dimension that each unit will extend beyond the edges of the slab at least twice the thickness of the pavement. After removal of side forms, the material shall be folded down over the edges of the pavement and secured by a continuous bank of earth. The covering shall be maintained in place for 72 hours after the concrete has been placed.

(e) Combined Burlap and White Polyethylene Sheeting: The burlap portion of each sheet shall be thoroughly wet down before use. After completion of finishing operations and immediately following the disappearance of surface water, the surface of the pavement shall be completely covered with the polyethylene side of the material up. The sheets of material shall be so placed and weighted as to cause it to remain in contact with the surface and separate sheets shall be lapped at least 6 inches. After removal of side forms, the material shall be folded down over the edges of the pavement and secured by a continuous bank of earth. Curing shall continue for a period of not less than 72 hours after the concrete has been placed.

(f) Curing in Cold Weather: When concrete is being placed and the air temperature may be expected to drop below 35°F, a sufficient supply of straw, hay, grass, approved curing paper, or other blanketing material shall be provided along the work, and any time the temperature may be expected to reach the freezing point during the day or night, the material shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete damaged by frost action shall be removed and replaced at the contractor's expense.

601.13 SURFACE TEST. As soon as the concrete has hardened sufficiently, the pavement surface will be tested by the Department with an approved 10-foot rolling straightedge capable of marking the deficient areas

by suitable means. The rolling straightedge shall be furnished by the contractor and shall be calibrated and used according to DOTD Designations: TR 603 and TR 618.

All testing will be made longitudinally for the full length of each traffic lane. Each section will be tested as early as possible in a longitudinal path at a transverse location selected in accordance with DOTD Designation: S 605.

For continuously reinforced concrete, not more than 4 percent of each lot, as defined in Subsection 601.21, shall show surface deviations in excess of ⅛ inch but not exceeding ¼ inch. For jointed pavement, not more than 8 percent of each lot shall show surface deviations in excess of ⅛ inch but not exceeding ¼ inch.

When a greater percentage of the lot shows deviations within this specified range, or when roadway areas show deviations in excess of ¼ inch but not exceeding ½ inch, the deficient areas must be ground down with an approved grinding tool to within the ⅛ inch tolerance.

On ramps and connections, a maximum deviation of ¼ inch in 10 feet will be allowed. Areas showing deviations in excess of ¼ inch, but not exceeding ½ inch, must be ground down to within the ¼ inch tolerance.

Where the surface deviation in 10 feet exceeds ½ inch, the pavement shall be removed and replaced by, and at the expense of, the contractor.

After grinding, the finished surface of the ground areas shall be provided with a uniform texture consistent with adjacent pavement.

601.14 REMOVING FORMS. Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully to avoid damage to the pavement. After forms have been removed, the sides of the slab shall be cured in accordance with Subsection 601.12. Minor honeycombed areas shall be filled with mortar composed of one part of cement and two parts of fine aggregate. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 10 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length shall also be removed and replaced.

601.15 SEALING JOINTS.

(a) General Requirements: The engineer shall inspect and approve each joint for proper width, depth, alignment and preparation for sealing before sealing is allowed. Sealing of joints will not be required when new portland cement concrete is to be overlaid with asphaltic concrete.

The pavement may be opened to traffic prior to sealing provided the joint

forming device or insert has not been removed or sawed. When the insert is removed or sawed the pavement may be opened to traffic provided the joints are protected during the interval between sawing and sealing. Protection of the joints shall be accomplished by placement of a backup material immediately after sawing or removal of insert. The elastomeric polymers (poured sealers) require that the concrete be at least 28 days old prior to sealing joints.

The joint shall be thoroughly cleaned immediately prior to sealing. Poured sealers require that joint faces be sandblasted immediately prior to sealing. Sandblasting is not required for preformed elastomeric compression seal except when the joint insert is sawed.

The sealant shall be placed as soon as possible after the required curing of the concrete. Traffic shall not be permitted while sealing and until after the sealant is cured. When a liquid poured sealant in accordance with Subsection 1005.02 is used, the pavement shall be closed to all traffic for sealing for a minimum of one day. When elastomeric compression seal is used, the pavement may be opened to traffic immediately following completion of sealing.

Joints shall be reasonably free of spalls, fractures, breaks or voids. Areas requiring repairs shall be chipped back to sound concrete and repaired with an approved non-shrinking patching system in accordance with the manufacturer's recommendations.

Joint sealants shall be installed in accordance with the manufacturer's recommendations. The sealant shall be installed to a depth of ¼ inch ($\pm$⅛ inch) below the pavement surface or in accordance with the plans. The sealants used shall conform to the following:

(1) **Longitudinal joints** — as specified in Subsection 601.10.

(2) **Transverse expansion joints** — as specified in Subsection 601.10.

(3) **Transverse contraction and construction joints** — shall be sealed with preformed compression joint seal in accordance with Subsection 1005.03, unless otherwise noted on the plans.

(b) Additional Requirements: The following additional requirements apply to the installation of elastomeric polymers and preformed compression seals conforming to Subsections 1005.02 and 1005.03.

(1) Hot Poured Sealants:

a. Joint Preparation: The joints shall be either formed or cut in accordance with Subsection 601.10. Removal of joint forming devices or sawing operation shall not commence until immediately before cleaning and application of the sealant material. All joints shall be thoroughly cleaned by commercial type sand blasters capable of effectively removing all concrete curing membrane, laitance and

other foreign matter from the joint. The sandblasting operation shall continue until the joint exhibits a uniform etched surface. Upon completion of sandblasting, the joint and adjacent areas shall be cleaned of all dust and sand.

b. Application: Poured sealers conforming to Subsections 1005.02(a) and 1005.02(c)(2) shall be installed in accordance with the following requirements.

The sealant shall not be installed until the joint has been inspected and approved. A backing material shall be placed as shown on the plans and shall be non-adhesive to the concrete or the sealant material. The material shall be upholstery roving cord. The joint sealant shall be applied uniformly solid from bottom to top in accordance with details shown on the plans. The joint shall be filled without formation of entrapped air or voids. The air temperature at the time of installation shall be 60°F or above.

A mobile, heated, double walled, agitator type kettle with suitable oil medium in the outer space for heat transfer capable of maintaining a temperature range of the sealant material of 240°F to 280°F will be required. The kettles shall have easy access to facilitate cleaning and shall be thoroughly cleaned of any foreign substances or previously used compounds and shall be flushed daily with flushing oil. This equipment shall be provided with automatic continuous temperature recording chart for constant kettle temperature surveillance. A direct connecting pressure type extruding device with nozzles shaped for insertion into the joint to be filled shall be provided. The application equipment shall be designed so that the sealant material may be recirculated in the inner kettle when not in use and shall be capable of filling the joint with sealant material free of voids or entrapped air. The applicator shall be approved by the engineer and shall be maintained in satisfactory working condition.

(2) Polyurethane Polymers, Subsection 1005.02(b): Care shall be taken that the material's shelf life is not exceeded and that application is accomplished at a temperature of 70°F or above.

(3) Preformed Elastomeric Compression Seals, Subsection 1005.03: Dilution of the lubricant adhesive is discouraged; however, a maximum of 10 percent dilution with a material recommended by the manufacturer will be allowed when application is by pump and the viscosity is such that the lubricant adhesive will not flow through a pump. The lubricant adhesive shall be applied just prior to installation of the seal and shall be sufficient to completely cover the seal's sidewalls.

The sealer shall be machine installed on all projects requiring 10,000 feet or more sealing. Stretching of the compression seal shall not exceed

5 percent. Prior to beginning installation, a length of sealer equal to the width of the pavement shall be cut and installed so that the stretching may be measured for the method of installation used. Random checks for stretching shall then be made throughout the project as deemed necessary by the engineer. If the lubricant adhesive has chemically set and maximum stretch limits are exceeded, the seal shall be removed and cleaned, the joint recleaned and reinstallation made.

Field splicing will not be allowed unless otherwise noted on the plans.

The sizes of compression seals to be used are as follows:

Joint Width	Seal Width
5/8''	1-1/4''
7/16''	13/16''
3/8''*	11/16''

*This joint width and the corresponding seal width will be allowed only when an approved removable joint forming device capable of accurately forming the ⅜'' joint width is used and no sawing is permitted.

601.16 PROTECTION OF PAVEMENT. The contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges or crossovers, etc. as necessary.

Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced.

601.17 SPLIT SLAB CONSTRUCTION. There will be no additional payment for split slab construction. When the use of the split slab method is requested by the contractor, written authority of the engineer shall be obtained.

Longitudinal joints in pavement constructed by the split slab method shall conform to Subsection 601.10. The longitudinal joint shall be hand edged a distance of approximately 2 inches back from the edge of the slab after final finish when tine finish is required. Pavement constructed by this method shall in all other respects conform to these specifications.

601.18 SLIP FORM PAVING METHOD. The slip form paving method may be used at the option of the contractor.

(a) Grade and Alignment: After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The requirements of Subsection 601.06 shall apply for preparing and maintaining the grade during paving operations. The slip

form paver shall have the capability of maintaining the correct alignment and grade. The edge line shall not deviate from true alignment by more than ½ inch at any point.

(b) Placing Concrete: The concrete shall be placed with an approved slip form paver designed to spread, consolidate, screed and float-finish the freshly placed concrete in one pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense, homogenous pavement in conformance with the plans and specifications. The machine shall be equipped with vibrators conforming to Subsection 601.03(a) and the concrete shall be vibrated for the full width and depth of the pavement being placed. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. If trailing forms are used, the forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur. All vibration of concrete and vibratory placement of load transfer devices shall occur within the confines of the trailing forms.

The concrete shall be held at a uniform consistency. The slip form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress. If it is necessary to stop the forward movement of the paver, the vibrator and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine except that which is controlled from the machine.

(c) Finishing: The surface smoothness and texture requirements shall be as described in Subsection 601.11, except that the tolerance for the 6-inch width just inside the edge of the pavement shall be ¼ inch under the 10-foot straightedge except where the edge will be a longitudinal joint in widening the pavement.

(d) Curing: Curing shall be done in accordance with Subsection 601.12. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

(e) Joints: All joints shall be constructed and sealed in accordance with Subsections 601.10 and 601.15.

(f) Protection Against Rain: In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor shall have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap mats, curing paper or plastic sheeting material for the protection of the surface of the

pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

601.19 CONTINUOUSLY REINFORCED PAVEMENT. Construction of continuously reinforced pavements shall conform to the requirements of this Section with the following modifications.

(a) Placement of Reinforcement: Reinforcement shall be preset on approved chairs. The arrangement and spacing of chairs shall be such that the reinforcing steel will be supported in proper position during placing and consolidation of concrete, and any deflection or displacement will not exceed the tolerances for the vertical position of the reinforcement in the pavement. They shall have sufficient bearing at their base to prevent overturning or penetration into the base. They shall be designed so as not to impede the placing and consolidation of concrete. Chairs should not be set so close to other transverse members as to make placing concrete through the space difficult. This is particularly important in lapped areas where there is a concentration of reinforcement. Welding of chairs to transverse bars will be permitted when approved in writing by the engineer.

In the normal 30 inches placement for the transverse bars, chairs shall be placed under every transverse bar. Transverse chair spacing shall be 48 inches maximum. Placement may be staggered so that chairs in alternate rows are centered between chairs in adjacent rows.

A minimum of 10 chairs per mat shall be used under prefabricated deformed mat reinforcing to meet the steel placement requirements.

The contractor shall submit a sample of the chair he proposes to furnish. Unless a specific spacing of chairs is designated on the plans, the contractor shall submit a drawing showing the layout he proposes to use. Chairs and layout shall be subject to the approval of the engineer. If the support system does not maintain the reinforcement in the required position during placing and finishing of the concrete, the contractor will be required to increase the number of chairs or take such other steps as required to assure proper position of the steel.

When the reinforcement consists of loose bars fabricated on the grade, longitudinal bars shall be secured to transverse bars by wire ties or clips at not less than each alternate intersection for all bars.

Deformed wire mats shall be preassembled and placed at the specified height prior to concrete operations.

Forms shall be oiled prior to placement of reinforcement.

(b) Lap Splices in Reinforcing Steel: Reinforcing bars or prefabricated deformed wire mats used as continuous reinforcement shall be lapped in the longitudinal direction in staggered pattern as shown on the plans. No

more than ⅓ of the longitudinal steel members within a single traffic lane shall terminate within a 2-foot distance measured along the centerline of the pavement.

When deformed wire mats are used, the mats shall be lapped transversely as shown on the plans with sufficient ties to hold them in specified position during concreting operations.

Splices for deformed steel reinforcing bars shall be a minimum of 30 times the nominal diameter of the bar. Bars of high yield steel shall not be bent. If the contractor elects to bend the tie bars, they shall be of structural or intermediate grade steel and spaced on 30-inch centers. All laps in reinforcement shall be tied or otherwise fastened securely.

(c) Placement of Concrete: Concrete shall be placed in one lift and struck off to full depth. An approved method of internal vibration shall be employed adjacent to lapped bars and below reinforcing steel to assure proper consolidation.

(d) Transverse Construction Joints: A transverse construction joint shall be installed at the end of each day's work or whenever paving operations must be interrupted for more than 30 minutes. The joint shall be formed by placing the concrete against a header board approved by the engineer. The header board may be set perpendicular to, or skewed with, the centerline of the pavement. Header boards shall not be skewed more than 15° from the pavement centerline. The longitudinal reinforcing steel shall extend through the header board and be properly supported from the grade beyond the header board to prevent deflections during paving operations.

Longitudinal reinforcing steel shall extend a sufficient distance ahead and back of the transverse construction joint so that no splicing steel is closer than 2 feet from the construction joint.

At all lap splices occurring within 8 feet forward of or within 3 feet back of the transverse construction joint in the direction of paving, the length of lap shall be double that normally specified or each splice shall be strengthened by splicing in a 6-foot length of deformed bar or wire of the same nominal size as the longitudinal reinforcement.

Construction joints shall be strengthened by the addition of supplementary deformed bars 4 feet long and of the same nominal size as the longitudinal reinforcement, placed at uniform spacing across the joint. The number of supplementary bars shall be such as to increase the cross-section area of the steel through the joint by at least 33 percent. Vibration with hand-manipulated mechanical vibrators will be required adjacent to all transverse construction joints.

(e) Longitudinal Construction Joints: If the contractor elects to continue the transverse steel through the joint, tie bars may be deleted.

601.20 OPENING TO TRAFFIC. The engineer will decide when the pavement shall be opened to traffic. The pavement will not be opened to traffic until specimen beams conforming to Subsection 601.07 have attained a flexural strength of 600 psi when tested by the third-point method in accordance with AASHTO Designation: T 97 or a compressive strength of 3,000 psi when tested in accordance with AASHTO Designation: T 22. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete has been placed. The pavement shall be cleaned and joints sealed in accordance with Subsection 601.15.

601.21 ACCEPTANCE FOR PAVEMENT STRENGTH AND THICKNESS.

(a) General: The strength and thickness of the pavement will be determined from hardened concrete cores in accordance with DOTD Designation: TR 225.

The completed pavement shall be accepted on a lot basis. A lot shall be considered as 3,000 linear feet of pavement when a single traffic lane is placed, 1,500 linear feet when two lanes are placed concurrently, or 1,000 linear feet when three lanes are placed concurrently. The last unit in each slab shall constitute a lot in itself when its length is at least ½ of the normal lot length. A shorter length shall be included in the previous lot.

Other areas such as intersections, entrances, crossovers, ramps, etc., will be grouped together to form lots not exceeding 4,000 square yards each. Small irregular areas may be included with other unit areas to form a lot.

Each lot will be divided into 5 equal segments and one core will be obtained from each segment in accordance with DOTD Designation: TR 225 for thickness and strength testing.

(b) Pavement Thickness. After the pavement has met all surface smoothness requirements, cores for thickness measurements will be taken.

In calculating the average thickness of the pavement, individual measurements which are in excess of the specified thickness by more than 0.25 inch will be considered as the specified thickness plus 0.25 inch.

When the average thickness for the lot is deficient, the contract unit price will be adjusted for thickness in accordance with Schedule 1 in Subsection 601.23.

Individual areas found deficient in thickness by more than one inch shall be evaluated by the engineer, and, if in his judgment the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans. If the deficient area is allowed to remain in place, payment will be in accordance with Subsection 601.23.

(c) Pavement Strength. The average compressive strength for 5 cores per lot, as previously defined, will not be less than 4,000 psi (3,600 psi

when air entrainment is used).

When the average strength for the lot is less than 4,000 psi (3,600 psi when air entrainment is used), the contract unit price will be adjusted for strength in accordance with Schedule 2 in Subsection 601.23.

Whenever an individual core indicates compressive strength less than 3,000 psi, and if in the judgment of the engineer the concrete may be left in place, the quantity of concrete represented by the deficient core will be paid for in accordance with Subsection 601.23. If removal is warranted, the entire section will be replaced with concrete of the desired quality.

The compressive strength of cores will be determined after a minimum of 28 days.

601.22 METHOD OF MEASUREMENT. The quantities for payment will be the design quantities specified in the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

The design areas of pavement are based on the horizontal dimensions shown on the plans, the length being along the centerline of pavement.

Reinforcement, except for tie bars, load transfer devices and joint material, will be measured by the pound as shown on the plans, except as stated elsewhere herein for continuously reinforced pavement.

Continuously reinforced concrete pavement will be measured by the square yard from plan dimensions as described above. In continuously reinforced concrete pavement, all steel reinforcement and all joints other than the wide flanged beam joint will be included and paid for under this square yard measurement.

Wide flange installations will be measured by the linear foot transversely from plan dimensions, including welded end plates, in place.

601.23 BASIS OF PAYMENT. The accepted quantities of concrete pavement will be paid for on a lot basis at the contract unit price per square yard, which includes furnishing and placing all materials including tie bars, load transfer devices and joint material. Unit price adjustments will be made as prescribed herein.

No additional payment will be made for any pavement with an average thickness in excess of that shown on the plans.

Reinforcing steel except as stated elsewhere herein will be paid for separately.

Continuously reinforced pavement will be paid for at the contract unit price per square yard, which includes furnishing and placing all materials, including all steel reinforcement, tie bars and joint material.

The accepted quantity of wide flange installations will be paid for at the contract unit price per linear foot, which includes furnishing and installing all materials, including welded end plates, sleeper block and reinforcement; for all excavation and satisfactory disposal of surplus materials; and for all labor, equipment, and tools necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
601(1)	Portland Cement Concrete Pavement (_____" Thick)	Square Yard
601(2)	Portland Cement Concrete Pavement (_____" Thick) (Continuously Reinforced)	Square Yard
601(3)	Wide Flange Installations	Linear Foot
601(4)	Bar Reinforcing	Pound
601(5)	Fabric Reinforcing	Pound

Price Adjustments: Whenever the pavement does not conform to the requirements for acceptance as provided in Subsection 601.21, payment will be made at an adjusted unit price in accordance with the following.

(a) Adjustment for Thickness: When the average thickness of the pavement per lot is deficient, payment for the lot shall be adjusted as in Schedule 1.

Schedule 1

Deficiency in the Average Thickness of 5 Cores Per Lot Inches	Percent of Contract Price Per Lot
0— .10	100% Payment
.11— .25	95% Payment
.26— .50	80% Payment
.51—1.00	50% Payment
more than 1.00	Remove

When the thickness of pavement as measured by the individual core is deficient by more than one inch and the judgment of the engineer is that such deficient segment should not be removed and replaced, payment for such segment will be made at 50% of the contract unit price.

(b) Adjustment for Strength: When the average compressive strength of the pavement per lot is deficient, payment for the lot will be adjusted as in Schedule 2.

Schedule 2

Average Compressive Strength of 5 Cores Per Lot (psi) (Minimum of 28 days)		Percent of Contract Unit Price Per Lot
Without Air Entrainment	**With Air Entrainment**	
4,000 and above	3,600 and above	100% Payment
3,500 — 3,999	3,150 — 3,599	95% Payment
3,000 — 3,499	3,000 — 3,149	80% Payment
below 3,000	below 3,000	50% Payment or Remove

When the strength of an individual core is less than 3,000 psi and if in the judgment of the engineer the segment represented by this core may be allowed to remain in place, payment for such individual segment will be based on 50 percent of the contract unit price.

(c) **Final Adjustment in Unit Price Per Lot:** When test results are such that price adjustments would apply for both thickness and strength, only the price adjustment requiring the greater reduction will apply. When pavement is to remain in place, the price adjustment will not exceed 50 percent.

PART VII

INCIDENTAL CONSTRUCTION

Section 701

Culverts and Storm Drains

701.01 DESCRIPTION. This work consists of the construction or reconstruction of pipe culverts, pipe arch culverts, storm drains and sewers, hereinafter referred to as "conduit," in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

701.02 MATERIALS. Materials shall conform to the following Subsections and these additional requirements.

Corrugated Steel Pipe and Pipe Arch	1007.03
Bituminous Coated Corrugated Steel Pipe and Pipe Arch	1007.04
Asbestos Bonded Corrugated Steel Pipe and Pipe Arch	1007.05
Corrugated Aluminum Pipe and Pipe Arch	1007.09
Reinforced Concrete Pipe	1006.04
Nonreinforced Concrete Pipe	1006.03
Reinforced Concrete Pipe Arch	1006.20
Vitrified Clay Pipe	1006.10
Cast Iron Pipe	1007.12
Asbestos Cement Pipe	1006.14
Slotted Drain Pipe	1007.11
Structural Plate Pipe and Pipe Arch	1007.08
Joint Materials	1006.02

(a) General: At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

(b) Metal Sheet Thickness: Minimum sheet thickness for metal conduits shall be as specified on the plans or in the project specifications.

(c) Reinforced Concrete Pipe Class and Wall Thickness: Unless otherwise specified, the class and wall thickness for reinforced concrete

pipe shall be in accordance with Subsection 1006.04.

(d) Culvert Pipe or Pipe Arch: When the item "Culvert Pipe" or "Pipe Arch" is included in the contract, the contractor has the option of furnishing conduit of reinforced concrete, asbestos bonded corrugated steel, bituminous coated corrugated steel, or corrugated aluminum, unless otherwise specified.

(e) Pipe Conduit or Pipe Arch Conduit: When the item "Pipe Conduit" or "Pipe Arch Conduit" is included in the contract, the contractor has the option of furnishing conduit of reinforced concrete, bituminous coated corrugated steel, asbestos bonded corrugated steel, or corrugated aluminum, unless otherwise specified.

(f) Corrugated Metal Pipe or Corrugated Metal Pipe Arch: When the item "Corrugated Metal Pipe" or "Corrugated Metal Pipe Arch" is included in the contract, the contractor has the option of furnishing conduits of bituminous coated corrugated steel, asbestos bonded corrugated steel or corrugated aluminum, unless otherwise specified.

(g) Material Type Abbreviations and Definitions:

RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch
CMP	Corrugated Metal Pipe, Steel or Aluminum
CMPA	Corrugated Metal Pipe Arch, Steel or Aluminum
RCB	Reinforced Concrete Box Culvert
CSP	Corrugated Steel Pipe
CSPA	Corrugated Steel Pipe Arch
CAP	Corrugated Aluminum Pipe
CAPA	Corrugated Aluminum Pipe Arch
BCCSP	Bituminous Coated Corrugated Steel Pipe
BCCSPA	Bituminous Coated Corrugated Steel Pipe Arch
ABBCCSP	Asbestos Bonded Bituminous Coated Corrugated Steel Pipe
ABBCCSPA	Asbestos Bonded Bituminous Coated Corrugated Steel Pipe Arch
*T1	Type 1 Joint
*T2	Type 2 Joint
*T3	Type 3 Joint

*Note: Refer to Subsection 701.06 and Sections 1006 and 1007.

701.03 EXCAVATION. Trenches shall be excavated to a width sufficient to allow for proper joining of the sections of conduit and thorough compaction of the bedding and backfill material under and around the conduit. Where feasible, trench walls shall be approximately vertical.

The excavation for conduits that are placed in the embankment fill shall not be made until the embankment has been completed to a height of at least one

foot above the top of the conduit, or to subgrade if less than one foot.

Excavated material that is not satisfactory for backfill or is surplus material shall be disposed of by the contractor to the satisfaction of the engineer.

701.04 FORMING BED FOR CONDUIT. Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with satisfactory material in such a manner as to provide a compacted earth cushion having a thickness under the conduit of not less than ½ inch per foot for height of fill over the top of the conduit with a minimum allowable thickness of 8 inches.

When specified, additional excavation shall be performed below the established grade and bedding material placed. This work shall be performed and paid for in accordance with Section 726.

When it is determined by the engineer during construction that a suitable foundation cannot be obtained at the established grade and the item for bedding material has not been included in the contract, the unstable soil below the established grade shall be removed and replaced with approved bedding material properly compacted to provide adequate support for the conduit. This work shall be in accordance with the engineer's directions and will be paid for in accordance with the provisions of Subsection 104.03, Extra Work.

If conduit is not laid in a trench, a uniformly firm bed shall be made in the same manner as above specified for the preparation of the bottom of the trench.

701.05 LAYING CONDUIT. The conduit laying shall begin at the downstream end of the line. The lower segment of the conduit shall be reasonably in contact with the foundation throughout its full length. Bell or groove ends of concrete conduit and outside circumferential laps of flexible conduit shall be placed facing upstream. Metal conduit shall be placed with longitudinal laps or seams at the sides.

701.06 JOINING CONDUIT.

(a) Types of Joints: Unless otherwise specified the types of joints required for conduit installations shall be as follows.

(1) Type 1 joints shall be used for side drains.

(2) Type 2 joints shall be used for cross drains.

(3) Type 3 joints shall be used for closed sanitary and storm sewer systems, flumes and siphons.

(b) Concrete Conduit: Concrete conduit may be either bell and spigot or tongue and groove, unless one type is specified. The method of joining conduit sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be of the specified type conforming to Subsection 1006.04 and sealed with gasket material conforming to Subsection 1006.02, installed in accordance with the manufacturer's recommendations.

The primer and lubricant used to facilitate the joining of conduit, when rubber or plastic gasket are used, shall be that recommended by the manufacturer of the gasket material.

(c) **Metal Conduit:** Metal conduit shall be firmly joined by coupling bands conforming to Subsection 1007.01. Bands shall be fabricated from corrugated metal sheets of the same material as the conduit. The coating shall be the same as used on the conduit. The thickness of band may be 2 standard sheet thicknesses lighter than that of the conduit, but not more than 0.109 inch thick nor less than 0.064 inch thick. Bands shall lap over an equal portion of each of the conduit sections. The longitudinal seam under the bands may be riveted or welded at the contractor's option.

When Type 2 joints are specified, joining of the metal conduit sections shall conform to Subsection 1007.02 and the following provisions.

(1) **General:** Band joints shall be sealed with flexible plastic gasket material conforming to Subsection 1006.02(b). Plastic gasket rope shall be placed in 2 corrugation recesses on each side of conduit connection. Plastic gasket material shall also be placed on each band connection in such a manner that there will be no leakage. The gasket material shall be a minimum of ¾ inch diameter for ½ inch corrugation depth and a minimum of 1½ inches diameter for 1 inch corrugation depth, and placed and overlapped in accordance with the manufacturer's instructions.

(2) **Circular Section:** Connecting bands shall be 12 inches wide for conduit less than 36 inches in diameter and 24 inches wide for culverts 36 inches in diameter and greater. Bands shall be drawn tight by a minimum of 4 galvanized ½ inch steel rods and lugs. An equal number of rods shall be placed on each side of conduit connection with sufficient rods used to preserve the conduit alignment. Two steel rods shall be placed over the plastic gasket strips on each side of conduit connection. The galvanization of rods and lugs shall be in accordance with ASTM Designation: A 153 or A 164, Type GS.

(3) **Arch Section:** Connecting bands shall be 12 inches wide for pipe arch up to a 36 inch by 22 inch arch, and 24 inches wide for a 43 inch by 27 inch pipe arch and greater. Bands shall be connected at the ends by approved angle or strap connections. Connecting bands used for 43 inch by 27 inch pipe arch and above shall be 2-piece bands. Hardware shall be galvanized in accordance with ASTM Designation: A 153 or A 164, Type GS.

(d) **Cast Iron:** Cast iron pipe sections shall be firmly connected with approved joining materials and methods that provide watertight connec-

tions. Joints shall not be located within catch basins, manholes or other drainage structures.

701.07 RELAYING CONDUIT. If indicated or directed, existing conduits shall be removed and all suitable sections shall be relaid in the same manner as specified for new conduits.

701.08 BACKFILLING. Conduits shall be inspected before any backfill is placed and any found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the contractor's expense. After the conduit is installed, the trench shall be backfilled on each side of the conduit for the full trench width and to an elevation of 1 foot above the top of the conduit (or to subgrade if less than 1 foot) or to natural ground elevation, whichever is greater, with materials meeting the requirements of DOTD Designation: TR 423, Groups A-1-a, A-1-b, A-2-4, A-2-5, A-3, A-4 or A-6 with a maximum P.I. of 15, except that backfill materials for side drain conduits for driveway entrances and similar installations shall be material that is satisfactory to the engineer. All backfill material shall be approved before placement and shall be free from large lumps, rock or other objectionable matter.

When the top of the conduit is even with or below the top of the trench, backfill material shall be placed at or near optimum moisture content and compacted in layers not exceeding 6 inches (compacted) on both sides and to an elevation of 1 foot above the top of the conduit (or to subgrade if less than 1 foot) or to natural ground elevation, whichever is greater. Care shall be exercised to thoroughly compact the backfill material under the haunches of the conduit, and material shall be brought up evenly on both sides of the conduit for the full required length of fill.

When the top of the conduit is above the top of the trench, backfill shall be placed at or near optimum moisture content and compacted in layers not exceeding 6 inches (compacted) and shall be brought up evenly on both sides of the conduit for its full length to an elevation 1 foot above the top of the conduit (or to subgrade if less than 1 foot). The backfill material used in the trench section and the portion above the top of the trench for a distance on each side of the conduit equal to the horizontal outside diameter and to 1 foot above the top of the conduit (or to subgrade if less than 1 foot) shall conform to the requirements for backfill material in the first paragraph of this Subsection. The remainder of the backfill shall be material that is satisfactory for normal embankment construction.

The backfill material shall be compacted by approved methods to obtain not less than 95 percent of maximum density in the top layer of the completed section. Maximum density shall be determined in accordance with DOTD Designation: TR 418 and the in-place density determined by DOTD Designation: TR 401.

The exposed slopes at conduit ends shall be covered by approximately 12

inches of plastic soil material to protect the granular type backfill from erosion.

The contractor shall, unless otherwise directed by the engineer, complete the construction of the embankment to a minimum of 2 feet above the top of the conduit before heavy construction equipment is allowed to cross the installation. Where practicable, shallow installations with less than 2 feet of cover over the top of the conduit shall be constructed after all heavy hauling is completed over the conduit location. After completion of hauling operations, the contractor shall remove any excess thickness of cover material to grade shown on the plans.

Any conduit which is damaged during laying, backfilling or by subsequent construction, or by any other cause, shall be removed and replaced in accordance with the specifications at the expense of the contractor.

Upon completion of the project and at the time of the final acceptance, all conduits shall be cleaned of all debris, and all soil shall be removed to the invert elevation of the conduit, or in the case where the invert elevation is lower than the elevation of the outfall, to the elevation of the outfall.

701.09 STUBBING AND PLUGGING CONDUITS. When it is required that conduits be plugged, such plugs shall be constructed of Class R concrete conforming to Section 902. The thickness of the plug and method of construction shall be as directed.

When it is required that new conduits be stubbed into new or existing conduits or other structures, the connection shall be made with an approved mortar.

Such plugging or stubbing of conduits will be considered incidental to the work and will not be measured for direct payment.

701.10 METHOD OF MEASUREMENT. The length of conduit, both new and relaid, will be measured in linear feet by the following methods: (1) conduit not confined by a fixed structure or structures will be measured by the number of joints at the nominal length of each joint; (2) conduit confined by fixed structures will be measured along the conduit between the termini of the conduit in structure walls; (3) conduit confined by a fixed structure on one end and unconfined at the other end will be measured along the conduit from the terminus of the conduit in the structure wall to the unconfined end of the conduit.

Fabrication of conduit tees, elbows and other fittings will be measured per each fitting, and the length of conduit in such fittings will be included in the pay length measurement of the conduits of which they form a part.

Excavation required for installation of conduits will be considered incidental to the work and will not be measured for direct payment, except as otherwise specified in Subsection 203.19.

When the contract does not include a pay item for "Conduit Backfill" the furnishing and placing of backfill material from trench excavations for conduits will be considered as incidental to the work and will not be measured for direct payment. Any backfill material needed to complete the backfill above the natural ground line and around conduits that extend above the natural ground line will be measured and paid for under applicable earthwork item.

The furnishing and placing of backfill material necessary for the installation of side-drain conduits for driveway entrances and similar installations will be considered as incidental to the work and will not be measured for direct payment.

When the contract contains a pay item for "Conduit Backfill," the quantity to be measured will be the number of cubic yards (net section) in final position between the following limits:

Measurement will include backfill material in the trench up to the top of the original ground line, except that when the original ground line is less than 1 foot above the top of the conduit, measurement will include backfill material to a height of 1 foot above the conduit, (or to subgrade if less than 1 foot) but will not include any material placed outside of vertical planes 18 inches outside of and parallel to the outside wall of the conduit at its greatest horizontal dimension.

701.11 BASIS OF PAYMENT. The accepted quantities of conduit will be paid for at the contract unit price per linear foot of the types and sizes specified complete in place.

Fabrication of conduit tees, elbows and other fittings will be paid for at the contract unit price per each fitting.

When an item for "Conduit Backfill" is included in the contract, the accepted quantity of backfill will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
701(1)	Structural Plate Pipe (Size)	Linear Foot
701(2)	Structural Plate Pipe Arch (Size)	Linear Foot
701(3)	Corrugated Steel Pipe (Size)	Linear Foot
701(4)	Corrugated Steel Pipe Arch (Size)	Linear Foot
701(5)	Bituminous Coated Corrugated Steel Pipe (Size)	Linear Foot
701(6)	Bituminous Coated Corrugated Steel Pipe Arch (Size)	Linear Foot
701(7)	Asbestos Bonded Corrugated Steel Pipe (Size)	Linear Foot
701(8)	Asbestos Bonded Corrugated Steel Pipe Arch (Size)	Linear Foot

Item No.	Pay Item	Pay Unit
701(9)	Asbestos Bonded Corrugated Steel Pipe (Size) (Smooth Lined)	Linear Foot
701(10)	Asbestos Bonded Corrugated Steel Pipe Arch (Size) (Smooth Lined)	Linear Foot
701(11)	Corrugated Aluminum Pipe (Size)	Linear Foot
701(12)	Corrugated Aluminum Pipe Arch (Size)	Linear Foot
701(13)	Reinforced Concrete Pipe (Size)	Linear Foot
701(14)	Reinforced Concrete Pipe Arch (Size)	Linear Foot
701(15)	Concrete Sewer Pipe (Size)	Linear Foot
701(16)	Vitrified Clay Pipe (Size)	Linear Foot
701(17)	Asbestos Cement Pipe (Size)	Linear Foot
701(18)	Cast Iron Pipe (Size)	Linear Foot
701(19)	Culvert Pipe (Size)	Linear Foot
701(20)	Pipe Arch (Size)	Linear Foot
701(21)	Pipe Conduit (Sizes and Types)	Linear Foot
701(22)	Pipe Arch Conduit (Sizes and Types)	Linear Foot
701(23)	Corrugated Metal Pipe (Size)	Linear Foot
701(24)	Corrugated Metal Pipe Arch (Size)	Linear Foot
701(25)	Relaying Conduit	Linear Foot
701(26)	Conduit Backfill	Cubic Yard
701(27)	Fabricating Conduit Fittings	Each
701(28)	Slotted Drain Pipe	Linear Foot

Section 702

Manholes, Inlets and Catch Basins

702.01 DESCRIPTION. This work consists of the construction and adjustment of manholes, inlets, junction boxes and catch basins in accordance with these specifications, and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

702.02 MATERIALS. Concrete for these structures shall be Class A conforming to Section 902. Other materials shall conform to the following Sections or Subsections.

The contractor shall have the option of furnishing structures of either cast-in-place concrete or precast concrete units; however, the design and installation procedures for precast concrete units will be subject to Department approval.

Brick	1004.01
Manhole Steps, Frames, Grates and Covers	1017.04
Asphaltic Varnish	1008.12
Reinforcing Steel	1009.01
Precast Reinforced Concrete Units	1016

Mortar shall consist of 1 part portland cement, 2 parts approved sand, and water as required for proper consistency. Mortar shall be used within 30 minutes after mixing.

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

702.03 CONSTRUCTION REQUIREMENTS. Concrete construction shall conform to Section 805. Joints shall be full mortar joints and shall not be more than ½ inch wide. When specified, the outside faces of structures shall be plastered with ½ inch thick cement-sand mortar coat. Unless otherwise provided, exposed surfaces of concrete and masonry shall be cured by approved methods for a period of not less than 48 hours.

Precast concrete units shall be cast with the specified number and size of pipe openings to incorporate the unit into the drainage system; however, if additonal pipe is required during construction for which no holes have been provided, the contractor may make such holes provided any damaged units are replaced or satisfactorily repaired. Precast units shall be set to within ± ½ inch of established grade on bedding material as shown on the plans or approved by the engineer. Joints for sectional precast units shall be sealed with flexible plastic gasket material conforming to Subsection 1006.02(b) so installed as to form a watertight seal.

Metal frames shall be set in full mortar bed. Conduit sections shall be flush on the inside of the structure wall and project outside sufficiently for proper connection with the next pipe section. Masonry shall fit neatly and tightly around the conduit.

When grade adjustment of existing structures is specified, the frames, covers and gratings shall be removed and the walls reconstructed as required. The cleaned frames shall be reset at the required elevation. All metal parts shall be thoroughly cleaned and placed in good repair. When permitted by the engineer, in lieu of adjusting structures by the foregoing method, the contractor may adjust the structures to the required grade by means of approved metal adjustment rings.

Upon completion, each new or adjusted structure shall be cleaned of any accumulations of silt, debris, or other foreign matter, and all metal parts shall be coated with asphaltic varnish. The structures shall be kept clear of such accumulations until acceptance of the work.

After inspection of completed structures and when directed, excavated areas not occupied by the structures shall be refilled to the required elevations. The material and requirements for backfilling these structures shall conform to Subsection 701.08.

Exposed slopes shall be covered by approximately 12 inches of plastic soil material to protect the backfill from erosion.

Excavated material not satisfactory for backfill, and surplus material, shall be disposed of by the contractor to the satisfaction of the engineer.

702.04 METHOD OF MEASUREMENT. Junction boxes, manholes, inlets and catch basins, both new and adjusted will be measured by the unit.

Excavation required for installation of these units will be considered incidental to the work and will not be measured for separate payment.

When the contract does not contain a pay item for "Conduit Backfill," the furnishing and placing of backfill material will be considered incidental to the work and will not be measured for separate payment.

When the contract contains a pay item for "Conduit Backfill," the quanti-

ties of backfill for payment will be the design volumes as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. The design volumes are based on the plan depths of the structure and vertical planes 18 inches outside of and parallel to the neat lines of the structure as shown on the plans.

702.05 BASIS OF PAYMENT. The accepted quantities of new and adjusted junction boxes, manholes, inlets, and catch basins will be paid for at the contract unit price per each complete in place.

When the contract includes an item for "Conduit Backfill" payment for the accepted quantity of backfill will be made in accordance with the provisions of Subsection 701.11.

Payment will be made under:

Item No.	Pay Item	Pay Unit
702(1)	Junction Boxes	Each
702(2)	Manholes	Each
702(3)	Inlets	Each
702(4)	Catch Basins	Each
702(5)	Adjusting _____	Each

Section 703

Underdrains

703.01 DESCRIPTION. This work consists of constructing pipe underdrains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

703.02 MATERIALS. Materials shall conform to the following Subsections.

Perforated Corrugated Steel Pipe	1007.06
Perforated Bituminous Coated Corrugated Steel Pipe	1007.07
Perforated Concrete Pipe	1006.05
Perforated Asbestos Cement Pipe	1006.15
Perforated Clay Pipe	1006.12
Perforated Corrugated Aluminum Pipe	1007.10
Perforated Bituminized Fiber Pipe	1006.19
Asbestos Cement Pipe	1006.14
Bituminized Fiber Pipe	1006.17, 1006.18
Plastic Pipe	1006.21
Granular Material	1003.08

Plastic filter cloth shall be an approved product on the Department's Qualified Products List and the same product shall be used throughout the project.

When an item for "Perforated Pipe Underdrains" is included in the contract, the contractor will be permitted to furnish any of the perforated types listed above.

When an item for "Nonperforated Pipe Underdrains" is included in the contract, the contractor will be permitted to furnish any of the nonperforated types listed above.

When the locations of manufacturing plants allow, the plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

703.03 PIPE INSTALLATION. Trenches shall be excavated to the dimensions and grade required by the plans or as directed. A minimum 3-inch thick bedding layer of granular material shall be placed and compacted in the bottom of the trench for its full width and length.

Underdrain pipe shall be embedded firmly in the bedding material.

Perforated pipe shall be placed with the perforations down, and the pipe sections shall be joined securely with the appropriate coupling fittings or bands. When specified on the plans, perforated pipe shall be wrapped with plastic filter cloth in accordance with plan details or as directed.

Nonperforated pipe shall be laid with the bell end upgrade and with open joints, wrapped with suitable material to permit entry of water; or unwrapped as specified.

Upgrade ends of all subdrainage pipe installations shall be closed with a suitable plug to prevent entry of soil materials.

After the pipe installation has been inspected and approved, granular backfill material shall be placed as shown on the plans or as directed. Care shall be taken not to displace the pipe or the covering at open joints. The contractor shall satisfactorily dispose of all excess excavated material.

703.04 METHOD OF MEASUREMENT. Measurement will be made by the linear foot of underdrain pipe, complete in place and accepted, and includes all required tees, elbows and other fittings. All required excavation, backfill and bedding materials, and plastic filter cloth will be considered as incidental to the work and will not be measured for separate payment.

703.05 BASIS OF PAYMENT. The accepted quantities of underdrains will be paid for at the contract unit price per linear foot, complete in place.

Payment will be made under:

Item No.	Pay Item	Pay Unit
703(1)	Perforated Corrugated Steel Pipe (Size)	Linear Foot
703(2)	Perforated Bituminous Coated Corrugated Steel Pipe (Size)	Linear Foot
703(3)	Perforated Concrete Pipe (Size)	Linear Foot
703(4)	Perforated Asbestos Cement Pipe (Size)	Linear Foot
703(5)	Perforated Corrugated Aluminum Pipe (Size)	Linear Foot
703(6)	Perforated Bituminized Fiber Pipe (Size)	Linear Foot
703(7)	Perforated Clay Pipe (Size)	Linear Foot

Item No.	Pay Item	Pay Unit
703(8)	Perforated Asbestos Cement Pipe (Size)	Linear Foot
703(9)	Bituminized Fiber Pipe (Size)	Linear Foot
703(10)	Perforated Plastic Pipe (Size)	Linear Foot
703(11)	Perforated Pipe Underdrains (Size)	Linear Foot
703(12)	Nonperforated Pipe Underdrains (Size)	Linear Foot

Section 704

Guard Rail

704.01 DESCRIPTION. This work consists of furnishing and constructing beam type highway guard rail in accordance with these specifications, and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

704.02 MATERIALS. Materials shall conform to the following Subsections.

Metal Beam Rail	1010.09
Posts and Spacer Blocks	1010.10
Hardware	1010.11
Wire Rope and Fittings	1010.12

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots as to quality.

Unless otherwise specified, galvanized steel guard rail shall be furnished.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

704.03 POSTS. Posts shall be set plumb. When driving is permitted, the manner of driving shall be such as to avoid battering or distorting of posts. Post holes shall be backfilled with acceptable material placed in layers and thoroughly compacted. Where posts fall within existing surfaced areas, the surface material shall be replaced in kind immediately upon completion of the installation.

704.04 RAIL ELEMENTS. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.

Holes for special details may be field-drilled or punched when approved by the engineer.

Galvanized surfaces that are damaged shall be repaired in accordance with Subsection 811.16.

704.05 METHOD OF MEASUREMENT. The quantities of guard rail, anchor sections and transitions for payment will be the design quantities as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

Design quantities of single faced guard rail are based on the plan length along the face of the rail between end posts, exclusive of openings, and the plan length of end sections. Design quantities of double faced guard rail are based on the plan length between end posts along the centerline of posts, exclusive of openings, and the plan length of end sections. Design quantities of trailing end and breakaway cable terminal (BCT) anchor sections are based on the plan length along the face of the rail.

704.06 BASIS OF PAYMENT. The accepted quantities of guard rail, anchor sections and transitions will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
704(1)	Guard Rail	Linear Foot
704(2)	Guard Rail (Double Faced)	Linear Foot
704(3)	Blocked Out Guard Rail	Linear Foot
704(4)	Blocked Out Guard Rail (Double Faced)	Linear Foot
704(5)	Guard Rail Anchor Sections (BCT)	Linear Foot
704(6)	Guard Rail Anchor Sections (Trailing End)	Linear Foot
704(7)	Guard Rail Bridge Attachments	Linear Foot
704(8)	Guard Rail Transitions	Linear Foot

Section 705

Fences

705.01 DESCRIPTION. This work consists of the construction of fences and gates in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

705.02 MATERIALS. Materials shall conform to the following Sections and Subsections.

Mesh (Woven) Wire	1010.02
Barbed Wire	1010.01
Chain Link Fence and Gates	1010.08
Posts	1010.03
Gates	1010.05
Staples	1010.06
Braces	1010.04
Metal Fasteners for Steel Posts	1010.07
Portland Cement Concrete	902

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

705.03 GENERAL CONSTRUCTION REQUIREMENTS. All clearing and grubbing necessary for satisfactory fence installation shall be performed in accordance with Section 201.

The contractor's activities and operations shall be confined to the area immediately adjacent to the right-of-way lines and within the right-of-way.

Where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made for the type of closure indicated.

When the plans require that posts, braces or anchors be embedded in concrete, the contractor shall install temporary guys or braces as may be required to hold the posts in proper position until such time as the concrete has set

sufficiently to hold the posts. Unless otherwise permitted, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until 3 days after placing the concrete.

Tops of posts shall be set to the required grade and alignment. Cutting of the tops of the posts will be allowed only with the approval of the engineer.

All wire shall be stretched taut and be installed to the approximate required elevations.

Electrical Grounds: Whenever a power line passes over the fence, a ground rod shall be installed directly below the point of crossing and 500 feet each side of this point. Ground rods shall also be installed, along the fence at 500-foot (maximum) intervals when a power line parallels and is over or adjacent to the fence, in which case each segment of fence shall be grounded. The ground rod shall be a ⅝ inch nominal (½ inch minimum) diameter copper-weld steel rod 8 feet long and shall be driven vertically until the top of rod is approximately 6 inches below the top of ground. An AWG No. 6 solid copper conductor shall be firmly attached to the rod and to the fence in such a manner that each element of the fence is grounded. The cost for the required ground rod installation shall be included in the price bid for fence and gate items.

705.04 REBUILT FENCE. Where indicated on the plans or directed, the contractor will be required to take down, move back and rebuild existing fence. The fence shall be rebuilt in the same manner as specified for new fence. Rebuilt ornamental fence, picket fence or other special types of fence shall be equal in all respects to the existing fence.

705.05 GATES. Gates of a different design from that shown on the plans may be furnished if prior approval is obtained from the Department.

All gates shall be of rigid construction, and after erection shall not show any sag or warp.

705.06 CHAIN LINK FENCE AND GATES.

(a) Concrete Post Anchorage: Posts shall be anchored in cast-in-place Class R concrete footings.

Hand mixing of concrete will be permitted for cast-in-place concrete where small quantities are to be mixed and when done to the satisfaction of the engineer. No hand mixed batch shall exceed ½ cubic yard.

Tops of footings shall extend slightly above the ground line and shall be steel troweled to a smooth finish with slope to drain away from the post as shown on the plans. Posts, braces, and other units shall be centered in their footings.

Concrete shall be placed promptly and without segregation after mixing. The contractor shall consolidate the concrete satisfactorily by tamping or

vibrating. Exposed edges shall be tooled. All excess excavation from footings shall be disposed of in a manner satisfactory to the engineer.

(b) Fence Erection: The fence shall be erected to the established lines and grades. The fence shall be approximately true to line, taut and shall comply with the best practice for fence construction of this type.

Posts shall be spaced in line of fence not further apart than 10-foot centers. Where breaks in a run of fencing are required, or at intersections with existing fencing, appropriate adjustments in post spacing shall be made for the type of closure indicated. Posts shall be erected plumb and in the specified alignment.

Pull posts shall be placed approximately 330 feet apart in straight runs and at each vertical angle point of 20 degrees or more, all as directed. Corner posts shall be placed at each horizontal angle or point of 20 degrees or more. Corner and pull posts shall have a horizontal brace and a tie rod on each side of the posts, extending and connected to the adjacent line posts.

Posts shall be permanently positioned, anchorages firmly set and top rail satisfactorily secured to all posts before fabric is placed. Ends of the fabric shall be secured by use of stretcher bars threaded through the loops of the fabric and secured to the posts by means of the specified number of clamps with bolts and nuts.

The fabric shall be placed by securing one end and applying sufficient tension to remove all slack before making attachments elsewhere. The degree of tensioning shall be commensurate with air temperatures at the time of installation to prevent undue sagging or tensioning of the mesh because of changing temperatures. The fabric shall be fastened to each line post at approximately equal spaces and to the top rail and bottom tension wire with tie wires or bands as specified or as directed.

(c) Gate Erection: Gate installation shall include gate frames, stretcher bars, filler fabric, latches, stops, locking device, padlocks, hinges, gate posts with braces, tie rods, turnbuckles, caps and all fittings and details for gates and gate posts, all as specified or required for complete installation.

All gates shall be carefully aligned with posts vertical. Where clamps are used for attaching hardware, they shall be made up tight. The bottom of each gate shall clear the ground by at least 3 inches at all points in its swing. The contractor shall modify the existing grade within the area of swing, if necessary, to meet this requirement when directed. Direction of swing and location of gates will be as specified or directed. Stops with latches, or other approved means for holding the gate open, shall be provided for all gates and so placed as to prevent damage to the gate or fence by overswing. Unless otherwise instructed, stops shall be provided also to arrest the swing of a closed gate at the centerline of the fence.

(d) Repair of Protective Coatings: After completion of fence and gate

installation, any damaged protective coatings shall be satisfactorily repaired by approved methods.

705.07 METHOD OF MEASUREMENT.

(a) New Fence and Gates: New fence will be measured by the linear foot between the outside of end posts for each continuous run of fence, exclusive of gates. Gates for new fence will be measured per each gate for single swinging gates, and per double gate for double swinging gates.

(b) Rebuilt Fence: Rebuilt fence will be measured by the linear foot between the outside of end posts for each continuous run of completed and accepted fence, inclusive of gates.

705.08 BASIS OF PAYMENT. The accepted quantities of fence and gates will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
705(1)	Barbed Wire Fence	Linear Foot
705(2)	Combination Mesh and Barbed Wire Fence	Linear Foot
705(3)	Single Swinging Walk Gates	Each
705(4)	Single Swinging Driveway Gates	Each
705(5)	Double Swinging Driveway Gates	Double Gate
705(6)	Chain Link Fence (__-Foot Height)	Linear Foot
705(7)	__-Foot Single Gates for Chain Link Fence (__-Foot Height)	Each
705(8)	__-Foot Double Gates for Chain Link Fence (__-Foot Height)	Double Gate
705(9)	Rebuilt Fence	Linear Foot

Section 706

Concrete Walks, Drives and Incidental Paving

706.01 DESCRIPTION. This work consists of the construction of concrete walks, drives and incidental paving slabs, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the engineer.

706.02 MATERIALS. Materials shall conform to the following Sections and Subsections.

Portland Cement Concrete	902
Joint Filler	1005.01
Reinforcing Steel	1009.01
Curing Materials	1011.01

Unless otherwise specified, all concrete shall be Class A.

706.03 CONSTRUCTION REQUIREMENTS.

(a) Excavation: Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The subgrade shall be shaped and compacted to a firm, even surface conforming to the section shown on the plans. All soft and yielding material shall be removed and replaced with approved material at the contractor's expense.

(b) Forms: Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, clean, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

(c) At the contractor's option, the concrete may be placed by slip-form methods. Slip-formed concrete shall be placed with an approved machine designed to spread, vibrate, consolidate and finish the concrete in one pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense, homogeneous unit. The sliding forms shall be rigidly held together to prevent spreading of forms, and after passing there shall be no noticeable slumping of concrete. The concrete shall be held at a uniform consistency, having a slump of ½'' to 2'' unless otherwise approved by the engineer. Air entrainment admixture in accordance

with Subsection 901.07(b) will be required in concrete used for slip-forming.

(d) **Subgrade:** The subgrade shall be thoroughly moistened immediately prior to the placing of the concrete.

(e) **Depositing and Finishing:** The concrete shall be deposited on the moist subgrade and struck off to the required thickness. It shall be tamped sufficiently to bring the mortar to the surface. The surface shall be finished with a wood float or steel trowel, provided that the surface is finally brushed in order to leave a slightly rough finish. All joints and edges shall be rounded with an edging tool having a ¼ inch radius.

(f) **Joints:** Expansion joints shall be of the dimensions specified, and shall be filled with premoulded expansion joint filler. Dummy joints shall be formed by a jointing tool or other acceptable means as directed. The dummy joints shall extend into the concrete for at least ¼ of the depth and shall be approximately ⅛ inch wide.

Construction joints shall be formed around all appurtenances such as manholes, utility poles, etc., extending into and through the paving. Unless otherwise specified, ¼ inch premolded expansion joint filler shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete paving and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the paving.

Unless otherwise specified, expansion joint filler shall be ½ inch thick and shall be installed every 100 feet or fraction thereof, between intersecting paving and any fixed structure such as a building, bridge or curbing. This expansion joint material shall extend for the full depth of the paving.

(1) **Walks:** Unless otherwise directed, the spacing of dummy joints for walks shall be equal to the width of the walk.

(2) **Drives:** A longitudinal dummy joint shall be formed along the centerline of drives more than 16 feet wide, and transverse dummy joints shall be formed in drives at not more than 16-foot intervals.

(3) **Incidental Paving:** Unless otherwise directed, dummy joints for incidental paving shall be formed at intervals not exceeding 20 feet in length or width; and incidental paving poured adjacent to existing jointed concrete shall be jointed to match the joints in the existing concrete, with intermediate joints formed as necessary not to exceed the 20-foot maximum joint spacing.

(g) **Curing:** Concrete shall be cured for at least 72 hours. Curing shall be done with the use of liquid membrane curing compound or by other approved methods. During the curing period traffic detrimental to the structure shall not be permitted. Vehicular traffic shall be excluded for such additional time as the engineer directs.

706.04 METHOD OF MEASUREMENT. The quantities of concrete walks, drives and incidental paving slabs for payment will be the design quantities as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. The design areas of concrete walks, drives and incidental paving slabs are based on the horizontal dimensions shown on the plans. Unless otherwise specified, all necessary excavation, backfill, reinforcing steel and joint materials will be considered incidental to the work and will not be measured for separate payment.

706.05 BASIS OF PAYMENT. The accepted quantities of concrete walks, drives and incidental paving will be paid for at the contract unit price per square yard, subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
706(1)	Concrete Walk (_____'' Thick)	Square Yard
706(2)	Concrete Drive (_____'' Thick)	Square Yard
706(3)	Incidental Concrete Paving (_____'' Thick)	Square Yard

Section 707

Curbs and Gutters

707.01 DESCRIPTION. This works consists of the construction of any of the types of curbs and gutters included in the following list in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions and typical sections shown on the plans or established by the engineer.

Concrete Curb
Concrete Gutter
Combination Curb and Gutter
Asphaltic Curb

707.02 MATERIALS. Except as provided below the materials shall conform to the following Section and Subsections.

Portland Cement Concrete	902
Joint Sealers	1005.03, 1005.04
Joint Fillers	1005.01

(a) Concrete Curbs and Gutters: Concrete for integral curbs shall be either Class A or the same type concrete used in the roadway pavement. Concrete for all other concrete curbs or gutter shall be Class A. If slip-formed methods are used, the concrete shall have not more than a 1½ inch slump and an air entraining admixture conforming to Subsection 901.07(b) will be required.

(b) Asphaltic Curbs: The asphaltic mixture for these curbs shall be asphaltic concrete wearing course conforming to Section 501, except that requirements for density and surface tolerance will be waived.

707.03 SUBGRADE. The subgrade shall be shaped to the required depth below the finished surface in accordance with the dimensions shown on the plans and shall be compacted to a firm, even surface. When possible, the subgrade shall be shaped and compacted at the same time and in the same manner as the subgrade for the pavement slab. All soft and yielding spots or any unstable material encountered shall be removed and replaced with suitable material, at the contractor's expense, and thoroughly compacted. When foundation underdrains are to be placed under curbing and gutter, the excavation and backfilling for same shall be completed and compacted before sub-

grade for curbing and gutter is prepared.

707.04 CONCRETE FORMS. The forms for the curbing or gutter shall be of wood or metal, straight, free from warp and of sufficient strength when staked to resist the pressure of the concrete without springing. All forms shall be cleaned thoroughly and greased or soaped before concrete is placed against them. Forms which have become worn, bent or broken shall not be used until satisfactorily repaired and straightened. Repaired forms shall not be used until inspected and approved by the engineer. An approved mechanical curb forming machine may be used without forms.

707.05 CONCRETE JOINTS. Joints shall be formed in integral curbing to correspond with transverse joints in the pavement slab. All joints shall extend entirely under the curb section and through the curb and shall be finished and filled with prescribed filler.

All other types of curbing shall be provided with ¼ inch joints at intervals of 20 feet, unless otherwise indicated on the plans, except where shorter sections are necessary for closures. The separation shall be effected by using steel plates ¼ inch in thickness, cut to true section, and set vertically in the forms until the concrete has set sufficiently to permit withdrawal of the plates.

707.06 DEPOSITING CONCRETE.

(a) Integral Types: After concrete pavement has been struck off, the curb form shall be clamped or otherwise securely fastened in place on the slab form, and the additional concrete for the curb shall then be deposited and thoroughly tamped. The additional concrete shall be placed within 30 minutes after the pavement slab has been finished, and care shall be taken to secure monolithic construction. All concrete shall be spaded or vibrated sufficiently to eliminate all voids and shall be tamped to bring the mortar to the surface, after which it shall be finished smooth and even with a wooden float. All edges shall be rounded with an approved finishing tool to the radius shown on the plans.

At the option of the contractor integral curb type may be placed after completion of the pavement, provided dowels are placed in the pavement of the size, type and spacing shown on the plans. No additional cost to the Department shall result from placing the curb by this method.

(b) All Types Except Integral: The concrete shall be placed on the prepared subgrade, struck off, and compacted to the required thickness. All concrete shall be spaded or vibrated sufficiently to eliminate all voids and shall be tamped to bring the mortar to the surface, after which it shall be finished smooth and even with a wooden float. All edges shall be rounded with an approved finishing tool to the radius shown on the plans.

(c) Slip-formed Concrete: Slip-formed concrete shall have a uniform consistency and shall be placed with an approved extrusion machine de-

signed to spread, consolidate and finish the concrete in one pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense, homogeneous unit. The sliding forms shall be rigidly held together to prevent spreading of the forms, and after passing there shall be no noticeable slumping of the concrete. The finished concrete shall be free from voids and any additional finishing required shall be performed immediately after placement.

707.07 FINISHING. The forms shall be removed within 24 hours after the concrete has been placed, and honeycombed areas and other minor defects shall be filled with mortar composed of portland cement and sand, mixed in the same proportion as provided for the concrete. Plastering will not be permitted on the faces of the curbing or gutter, and all rejected curb or gutter shall be removed and replaced without additional compensation. The top and face of the curb or gutter shall be finished while the concrete is still green by use of wood float, brush and water.

707.08 ASPHALTIC CURB. Asphaltic curb shall be placed to the section shown on the plans by the use of an approved extruding machine. Prior to placing the curb the contractor shall furnish and apply asphaltic tack coat, conforming to Section 503, as indicated on the plans.

707.09 CONCRETE CURING. After finishing, the curb or gutter shall be cured in the same manner and by one of the methods prescribed for portland cement concrete pavement in Section 601.

707.10 BACKFILLING. After the curb or gutter has set sufficiently, the contractor shall backfill adjacent to the curb or gutter with approved material. This material shall be thoroughly tamped in layers of not over 6 inches compacted thickness.

707.11 METHOD OF MEASUREMENT. The quantities of curbs and/or gutters for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Unless otherwise specified, all necessary excavation, backfill, joint materials, asphaltic tack coat and steel dowel bars will be considered incidental to the work and will not be measured for separate payment. When combination curb and gutter is specified, all gutters required in conjunction with catch basins will be included in the design quantities for combination curb and gutter.

707.12 BASIS OF PAYMENT. The accepted quantities of curbs and/or gutters will be paid for at the contract unit price per linear foot, subject to the following provisions:

(a) Asphaltic Mixtures: Asphaltic curbs will be subject to the price adjustment provisions of Section 501 for deviations in Marshall stability and aggregate gradation.

(b) Asphaltic Materials: In addition to price adjustments for asphaltic concrete mixtures, price adjustments will be applied for specification deviations of asphaltic materials as specified in Section 1002.

(c) Portland Cement Concrete: Portland cement concrete curbs and/or gutters will be subject to the price adjustment provisions of Section 902, and adjustments specified for Class A concrete will be applied.

Payment will be made under:

Item No.	Pay Item	Pay Unit
707(1)	Concrete Curb	Linear Foot
707(2)	Concrete Gutter	Linear Foot
707(3)	Combination Curb and Gutter	Linear Foot
707(4)	Asphaltic Curb	Linear Foot

Section 708

Right-of-Way Markers

708.01 DESCRIPTION. This work consists of furnishing and erecting concrete right-of-way markers in conformity with the design, dimensions and locations shown on the plans.

708.02 MATERIALS. Portland cement concrete shall have a minimum 28-day compressive strength of 3,000 psi based on cylinders molded, cured and tested in accordance with Subsection 901.07(f).

Reinforcing steel shall be deformed bars conforming to Section 806.

708.03 MARKERS. The markers shall consist of precast reinforced concrete posts installed on right-of-way lines at points designated on the plans or as directed.

The concrete posts shall be cast, finished and cured in the following manner.

(a) **Casting:** The concrete posts shall be cast in mortar-tight forms. Special care shall be exercised to puddle and tamp the concrete around the reinforcing steel and to avoid the formation of aggregate pockets. Concrete shall be placed continuously in each post.

(b) **Finishing:** Forms shall be removed as soon as the concrete has hardened sufficiently to prevent damage to marker. Markers shall be given a Class 1, Ordinary Surface Finish, in accordance with Subsection 805.13 and shall present a neat and uniform appearance.

(c) **Curing:** As soon as finished, markers shall be cured by an approved method for a period of not less than 3 days.

708.04 BACKFILLING. All posts shall be set to the depth indicated on the plans or as directed. Post holes shall be backfilled and thoroughly tamped as directed.

708.05 METHOD OF MEASUREMENT. Right-of-way markers will be measured by the marker and the number placed and accepted will be counted.

708.06 BASIS OF PAYMENT. The accepted quantity of markers will be paid for at the contract unit price per each, which includes concrete and reinforcing steel.

Payment will be made under:

Item No.	Pay Item	Pay Unit
708(1)	Right-of-Way Marker	Each

Section 709

Steel Rail Cattle Guards

709.01 DESCRIPTION. This work consists of furnishing and constructing welded steel rail cattle guards at the locations and conforming to the details shown on the plans, and in accordance with these specifications.

These specifications cover portable steel rail cattle guards that can be set in place on the reinforced concrete walls or footings. Cattle guards of types different from those shown on the plans may be furnished if prior approval is obtained from the engineer.

709.02 MATERIALS. Steel rails shall be of the unit weight specified on the plans.

Pipe wings shall be standard strength black or galvanized iron pipe, 2-inch diameter or as otherwise specified on the plans. Black pipe shall be painted in accordance with Section 811. Galvanized pipe will not require painting.

Concrete shall be Class A conforming to Section 902.

Reinforcing steel shall be deformed bars conforming to Section 806.

Treated timber where required shall be creosoted pine or Douglas fir and shall be Dense No. 1 structural grade conforming to Section 812.

Hardware shall be standard quality galvanized, of the size and dimensions recommended by the fabricator of the cattle guard and acceptable to the engineer.

709.03 EXCAVATION AND BACKFILL. A trench of sufficient width shall be excavated to the line and grade indicated on the plans or as directed. Excavation shall extend a minimum of one foot outside the neat lines of the concrete walls or footings.

The backfill shall be deposited in layers not exceeding 6 inches compacted thickness, and each layer shall be thoroughly compacted with mechanical tampers.

709.04 REINFORCED CONCRETE. Concrete and reinforcing steel shall be placed in accordance with the plans and these specifications. The reinforcing steel shall be securely fastened in an approved manner so as not to be displaced during the placing of the concrete.

709.05 PLACING TIMBERS. When timbers are required, they shall be placed as shown on the plans.

709.06 RAILS AND PIPE WINGS. Rails shall be placed in accordance with the details shown on the plans and welded together in an approved manner. Pipe wings shall be in accordance with plan details.

709.07 METHOD OF MEASUREMENT. Steel rail cattle guards will be measured as a unit, complete in place and accepted.

All required excavation, backfill, concrete and reinforcing steel will be considered as incidental to the work and will not be measured for separate payment.

709.08 BASIS OF PAYMENT. The accepted quantity of steel rail cattle guards will be paid for at the contract unit price per each, subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
709(1)	Steel Rail Cattle Guard	Each

Section 710

Removing, Relocating and Demolishing Structures

710.01 DESCRIPTION. Removing and relocating structures consists of the removal, preparation for moving and relocation of buildings or other structures of all types, hereinafter referred to as "structure," together with all existing service connections, appurtenances and accessories; reconstruction of all foundations and appurtenances, all in accordance with the plans and these specifications.

Moving of structures consists of moving units specified under the item "Removing and Relocating Structures" from the original location to the final location. This item includes the extension of existing water, gas, sewer and other service lines and utilities and all materials necessary therefor.

Demolishing structures consists of demolishing and disposing of all parts of the structure indicated on the plans, including foundations, basements, cisterns, underground tanks, walks, driveways or other artifacts.

710.02 GENERAL REQUIREMENTS. The Department reserves the right to eliminate from the work to be done by the contractor, the removal of any or all of the structures under these items, if deemed advisable by the engineer. Such elimination shall not affect the contract unit prices on the remaining structures to be moved, or the unit prices on the other items of the contract, and the contractor will not be entitled to any compensation due to such elimination.

In performing work in connection with removing and relocating structures, the contractor's attention is specifically directed to the requirements of Section 107.

710.03 REMOVING AND RELOCATING STRUCTURES. Structures shall be prepared for moving, removed and placed in their new locations, as shown on the plans or as designated, and left plumb and level and in as good condition in all respects as originally found. All units removed and relocated shall be placed on foundations of the same type and character as the original foundations.

Steps, outside stairways, canopies, porches, block or post supports, sills, chimneys on brackets and other appurtenances forming an integral part of the structure are to be considered as part of the structure and removed and re-

located accordingly. Cellars, cellar steps, concrete or masonry porches, concrete floors, solid or semi-solid concrete and masonry foundations and supports, septic tanks, fireplaces and chimneys standing on the ground, and other appurtenances attached or connected to the structure but not movable as an integral part of the structure shall be removed, relocated and/or replaced with foundations or appurtenances of the same size, type and character as existed before the structure was moved.

Wherever sanitary sewers, water, gas, electric, or telephone service lines are connected to the buildings being removed and relocated, the same shall be disconnected without unnecessarily discommoding the occupants of the building being moved. The contractor shall be responsible for all notices to the public utility companies and for all fees charged by them.

All privies, wash houses, garages, and other outbuildings, cisterns, wells, septic tanks and other appurtenances used in conjunction with a structure shall be removed and relocated. The contractor shall also remove and rebuild existing yard fences, driveways and walks and extend same as necessary. Existing shrubbery shall be removed and replanted at new locations as designated. All of the above shall be considered as appurtenances and appliances to the structures indicated on the plans to be removed and relocated.

Relocated wells shall conform to the Sanitary Code of the State of Louisiana as prepared and promulgated by the Louisiana State Board of Health.

The removal and relocation of a structure, any part of which is used as a filling station, unless otherwise noted on the plans, shall include the removal and relocation of all gasoline pumps, tanks, pipes, signs, and other accessories appurtenant to the filling station. Tanks shall be placed the same depth below the ground as existed before moving.

Material in the existing foundations, concrete or masonry floors, chimneys and other appurtenances, where not used in the reconstruction of the appurtenances shall be removed and disposed of as directed.

All new material required by the contractor in performing any of the above operations shall be furnished by the contractor at his expense.

The contents of all structures shall be removed and relocated along with the structure to its new site. If it is not feasible or possible to remove the structures together with the contents therein, the contents shall be removed from the structure at its original location and same replaced in the relocated structure. Such precautions as necessary shall be taken to prevent damage or loss of any kind to the contents thereof.

Cattle pens, cane derricks, cattle guards or other structures, detailed under this item, shall be removed and relocated or reconstructed on or beyond the rights of way line as directed. Materials in the existing structures, which are considered suitable for re-use, may be utilized in their reconstruction. All new materials required shall be similar in kind to that in place and shall be

furnished by the contractor at his expense.

Prior to the removal and/or relocation of tanks, the contractor shall notify and obtain approval of the Louisiana Liquefied Petroleum Gas Commission, Baton Rouge, Louisiana, in order that said Commission may have a representative present at time of removal should they desire. Should their representative be present and should he require that a new tank be furnished, the contractor shall replace the old tank with such new tank as required. The contractor will be reimbursed for the actual cost of the new tank furnished upon presentation of the original receipted bill, which payment will be in addition to the contract price under this item. If the removed tank is not to be re-used on this project, it shall be destroyed by the contractor, but in doing so, the contractor is warned of danger from accumulated gas in the old tank. A suggested method is first filling the tank with water and cutting off the neck; however, the Department will not be liable for any damage or loss from such operations. Said operations shall be the full responsibility of the contractor.

The contractor shall furnish the Department with a certificate of release from each property owner, and in the event of separate ownership of structure and property, a certificate of release from each owner shall be furnished. This certificate shall state that the structures removed and relocated are in an acceptable condition and that said owner waives all claims for damages to his property and structures removed.

710.04 MOVING OF STRUCTURES. The limits of moving of a structure unit shall be the distance from the center of the principal structure in its original location, measured along the shortest practical route of moving, to the center of the principal structure in its new location. Appurtenances to the principal structure will not be considered in the measurement, but shall be moved with the principal structure as a unit and re-established at the new location.

710.05 DEMOLISHING STRUCTURES. Unless otherwise provided, all materials in the designated structure shall become the property of the contractor. All portions of the structure shall be removed from the right-of-way and disposed of by the contractor.

710.06 METHOD OF MEASUREMENT. Removing and relocating structures will be measured by the structure designated on the plans. Each principal structure, together with its appurtenances and appliances, will be considered a complete and separate unit.

The moving of a structure will be measured in units of principal structure moved one foot which shall be designated a "structure foot."

Demolishing structures will be measured by the unit and shall include appurtenances, foundations, etc.

710.07 BASIS OF PAYMENT. Structures removed, moved, relocated and accepted, and structures acceptably demolished will be paid for at

the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
710(1)	Removing and Relocating Structures	Unit
710(2)	Moving Structures	Structure Foot
710(3)	Demolishing Structures	Unit

If a structure is included as a complete and separate unit under Item 710(1) for removal and relocation and the contractor enters into an aggreement with a property owner for demolishing or other disposition; or if it is subsequently determined that said structure previously scheduled for removal can remain in place, in whole or in part, with or without minor adjustments; and the contractor enters into an agreement with the property owner, incorporating such revised determination and any accompanying adjustments regarding said structure, including any possible elements of damages for leaving the building or structure in place; in either event, the contractor shall furnish the Department with said agreement for approval of the engineer.

The contractor will be paid for the demolishing or other handling of the structure at the total contract amount on the complete and separate unit as listed under Item 710(1), Removing and Relocating Structures.

Where the determination to allow the structure to remain in place involves a decrease in cost to the contractor, including any allowance for damages to the property owner and other adjustment, of the contract amount for the removal of said unit under Item 710(1), then an allowance will be made in such amount as the engineer deems fair and equitable.

If approval is given by the engineer, the contractor shall furnish the Department with a certificate of release from the property owner for the complete and separate unit. In the event of separate ownership of structure and property, a certificate of release from each owner shall be furnished. This certificate shall state that said owner or owners waive all claims for damages to his property and structure that has been demolished or otherwise handled to the owner's satisfaction.

No measurement or payment will be made under Item 710(2) for any such structure handled as provided herein.

Section 711

Riprap

711.01 DESCRIPTION. This work consists of furnishing and placing random riprap, riprap for sinking mattresses and heavy deposited riprap, all in accordance with these specifications and in reasonably close conformity to the lines, grades and thickness shown on the plans or directed by the engineer.

711.02 MATERIALS. Riprap shall consist of hard, durable stone that will not disintegrate upon exposure to the elements or be easily broken from handling, and shall be reasonably free from earth and other foreign materials. When tested in accordance with AASHTO Designation: T 85, the solid weight of the stone shall be at least 150 pounds per cubic foot (based on bulk specific gravity) and the absorption shall not exceed 2 percent. Samples of stone from a source not previously approved shall be taken under the supervision of the engineer and submitted for testing and approval prior to delivery to the project. The least dimension of individual stone shall be not less than ⅓ its maximum dimension, and each shipment of stone shall be reasonably well graded within the limits specified herein.

Unless otherwise specified, broken concrete conforming to these materials and gradation requirements may be used as riprap, provided its solid weight is at least 130 pounds per cubic foot (based on bulk specific gravity) and it is free of protruding reinforcement.

Control of gradation will be by visual inspection either at the source or the project site or both, at the engineer's option.

Any difference of opinion between the engineer and the contractor shall be resolved by checking the gradation of 2 random truckloads (or equivalent size samples). All necessary equipment, labor and sorting site shall be furnished by the contractor at his own expense.

(a) Random Riprap: Individual stones shall be not more than 18 inches in any dimension and at least 50 percent of the weight of the material shall consist of stones weighing not less than 35 pounds. The riprap shall contain not more than 5 percent of material by dry weight passing a ½ inch sieve.

(b) Riprap for Sinking Mattresses: Riprap for ballast to sink mat-

tresses shall be graded as follows:

Individual Stone Weight (Pounds)	Percent by Weight
75 to 100	0 to 20
25 to 74	60 to 100
10 to 24	0 to 20
Less than 10	15 Max.

(c) **Heavy Deposited Riprap:** Heavy deposited riprap shall be graded as follows:

Individual Stone Weight (Pounds)	Percent by Weight
250 to 350	10 to 20
150 to 249	60 to 90
50 to 149	0 to 25
Less than 50	15 Max.

711.03 CONSTRUCTION REQUIREMENTS.

(a) **Random Riprap:** Random riprap shall be dumped or rolled into place in such a manner that the smaller stones will be uniformly distributed throughout the mass. Sufficient hand work shall be done to procure a neat and uniform surface and to the depth shown on the plans or otherwise specified.

(b) **Riprap for Sinking Mattresses:** Riprap for ballast in sinking mattresses shall be uniformly distributed over the mattress by methods that will avoid damaging the mattress.

(c) **Heavy Deposited Riprap:** Areas on which heavy deposited riprap is to be placed shall be prepared, if required on the plans, by grading to the required sections. Heavy deposited riprap shall be placed and uniformly distributed over the areas. If placement in water currents is required, the contractor shall make drift checks and place the riprap in such manner as to compensate for the indicated drift. The contractor shall furnish all necessary facilities and personnel for checking the riprap depth and distribution.

711.04 METHOD OF MEASUREMENT. Random riprap will be measured by the cubic yard in vehicles at the point of delivery on the project in accordance with Subsection 109.01.

Riprap for sinking mattresses and heavy deposited riprap will be measured by the ton (2,000 pounds). If riprap is delivered by vehicles or railroad cars, measurement will be based on certified weight tickets furnished to the engineer by the contractor. If riprap is delivered by barge, measurement will be made by calculation from the barge displacement, based on water weighing 62.4 pounds per cubic foot.

No measurement will be made for any necessary excavation or backfilling, but the cost of this work will be included in the contract price for the riprap item.

711.05 BASIS OF PAYMENT. The accepted quantities of riprap will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
711(1)	Random Riprap	Cubic Yard
711(2)	Riprap for Sinking Mattresses	Ton
711(3)	Heavy Deposited Riprap	Ton

Section 712

Revetments

712.01 DESCRIPTION. This work consists of furnishing and constructing revetments for protection of embankment slopes, stream channels and other areas. Revetments shall be constructed in accordance with these specifications and in conformity with the details shown on the plans or as directed. Revetments shall be either Concrete Cast-in-Place Revetment or one of the following Flexible Revetments, as required by the plans:

Cellular Concrete Block on Plastic Filter Cloth
Sacked Concrete on Plastic Filter Cloth
Stone on Plastic Filter Cloth

When an item for "Flexible Revetments" is included in the contract, the contractor shall have the option of furnishing any one of the types of flexible revetments listed above; however, the same type revetment shall be used throughout the project, unless otherwise approved in writing by the engineer or specified in the plans or project specifications.

712.02 MATERIALS.

(a) Concrete: Concrete for cast-in-place revetment shall be Class R conforming to Section 902.

(b) Plastic Filter Cloth: Plastic filter cloth shall conform to Subsection 1017.15.

(c) Cellular Concrete Blocks: Cellular concrete blocks shall conform to Subsection 1004.04.

(d) Sacked Concrete: Sacks shall conform to Subsection 1017.21. Concrete shall be either Class R concrete conforming to Section 902 or other approved concrete mixture. The concrete may be either wet-batched or dry-batched, at the contractor's option, prior to placement in the sacks; however, the sacked concrete shall be immediately placed in the revetment after batching. Mixing water for wet-batched concrete, whether Class R or other approved mixture, shall be added as required to produce a slump in the range of 4 to 6 inches.

(e) Stone: Stone shall conform to Subsection 711.02 and shall be graded within the following limits. If not otherwise specified, Type A stone shall be furnished.

Percent By Weight	Stone Weight (Pounds)		
	Type A	Type B	Type C
10 maximum	26 to 36	88 to 122	190 to 230
40 to 60	9 to 14	28 to 46	65 to 100
20 to 40	4 to 9	14 to 28	35 to 65
15 maximum	Spalls under 4	Spalls under 12	Spalls under 30

Spalls will include all quarry chips and fines weighing less than the specified minimum which are retained on a rock fork whose tines are spaced one inch in the clear.

712.03 CONSTRUCTION REQUIREMENTS. All revetments shall be constructed in dry or dewatered areas, unless otherwise directed. All logs, stumps and other undesirable material shall be removed from the limits of construction to the satisfaction of the engineer. The entire area for the revetment system shall be filled and graded to obtain reasonable conformity with the grades and cross sections shown on the plans. Approved soil shall be used to bring the area to grade and compacted to the engineer's satisfaction before final grading.

(a) Concrete Cast-in-Place Revetment: Before placement, preformed ¼ inch thick expansion material conforming to Subsection 1005.01 shall be placed around piles, columns, etc. All costs of furnishing and placing preformed filler shall be borne by the contractor.

Placement of concrete revetment for slope protection shall commence at the toe or toewall of the revetment and progress upslope to the top of the revetment. Revetment for stream channels and other relatively level areas shall be placed as directed.

After placement, the surface of the revetment shall be kept moist or cured by other approved methods for at least 3 days.

(b) Plastic Filter Cloth Placement: The ends of filter cloth shall be buried for anchorage as shown on the plans. A minimum overlap of 10 inches is required for adjacent strips. Pins are required at 5-foot intervals to hold the overlap in place until revetment material is placed. Care shall be taken to prevent damage to filter cloth during placement of revetment material.

(c) Cellular Concrete Block Placement: Placing of blocks shall commence in a trench or against a suitable anchorage at the downslope end of ther area to be revetted and shall progress upslope. Each block shall be laid perpendicular to the slope and shall be bedded firmly against adjoining blocks. Cement grout may be required to fill unaligned joints or breaks at

slope changes if directed by the engineer. Individual blocks shall not be grouted to each other.

At the contractor's option, in lieu of placing the filter cloth and blocks separately, the revetment may be constructed by means of mattresses consisting of concrete blocks preset on the filter cloth with an adhesive; however, both the blocks and the filter cloth shall be approved products. If mattresses are used, the foregoing placement requirements may be modified as required to permit proper placement of the mattress panels; however, the 10'' overlap between adjacent panels shall apply.

After completion of the cellular block revetment, topsoil shall be loosely spread over the revetment to partially fill the cell openings. The topsoil shall be seeded and fertilized in accordance with Sections 717 and 718 at the time seeding operations are conducted on the project.

(d) **Sacked Concrete Placement:** Sacks of either wet-batched or dry-batched concrete shall be placed in contact with adjacent sacks and tamped into position by approved methods. Placement of sacked concrete shall begin at the toe or toewall of the revetment and progress upslope to the top of the revetment. Sacked concrete revetment for stream channels and other relatively level areas shall be placed as directed. If the sacked concrete revetment is composed of dry-batched concrete, the revetment shall be thoroughly wetted as directed immediately after completion of the entire revetment.

(e) **Stone Placement:** The toe and end walls shall be constructed by placing stone in the trench lined with plastic filter cloth. Placement of stone shall begin at the bottom of the slope in a layer having an average thickness as specified by the plans. Stone shall be placed by skip, clamshell or other methods approved by the engineer, and rearranged by hand as necessary to provide complete coverage of the section. A tolerance of 2 inches above or below the specified thickness will be allowed. Openings between stones exposing more than 4 square inches of filter cloth will not be permitted.

712.04 METHOD OF MEASUREMENT. The quantities of revetments for payment will be the design revetment areas as specified on the plans and adjustments thereto. The design quantities are based on the surface areas shown on the plans to be revetted. Site preparation and plastic filter cloth will be considered as incidental to the revetments and will not be measured for separate payment. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

712.05 BASIS OF PAYMENT. The accepted quantities of revetments will be paid for at the contract unit price. Payment for Concrete Cast-in-Place Revetment will be subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
712(1)	Concrete Cast-in-Place Revetment	Square Yard
712(2)	Cellular Concrete Block Revetment	Square Yard
712(3)	Sacked Concrete Revetment	Square Yard
712(4)	Stone Revetment	Square Yard
712(5)	Flexible Revetment	Square Yard

Section 713

Temporary Signs, Barricades and Pavement Markings

713.01 DESCRIPTION. This item consists of furnishing, installing and maintaining all temporary construction barricades, suitable lights, traffic control signals, pavement markings and signs; providing watchmen; and complying with all other requirements regarding the protection of the work, workmen and safety of the public. It shall also include furnishing and placing such other signs as may be required by the plans. Signs and barricades shall conform to the details and specifications shown on the plans, the Louisiana MUTCD and these specifications.

Signs and barricades, and the arrangements thereof, as shown on the plans, are minimum requirements of the Department. Special conditions shall be treated as such, and appropriate signs shall be furnished and installed as directed. Requirements as to proper signs and barricades, or other safety precautions as may be promulgated by the contractor's insurers, are not negated by these specifications. In no way shall these specifications be construed as relieving the contractor of any of his responsibilites for the safety of the traveling public, for any liability in connection therewith, or compliance with State and local laws or ordinances.

713.02 MATERIALS. Materials and fabrication for temporary signs, barricades and related devices shall conform to Section 729, the plans and the following specific references.

Backing material for construction signs shall conform to Subsection 1015.04.

Barricade warning lights shall conform to Subsection 1017.12.

Temporary pavement markings shall conform to Subsection 1015.08.

713.03 CONSTRUCTION REQUIREMENTS. Signs, barricades and related devices will be required during such time as the contractor's work is in progress on the portions of the work covered by the Notice to Proceed, or when his operations are suspended but the traveled portion of the road is not in such condition as to be safe for the traveling public. During such times that barricades are not in place, appropriate regulatory signs shall be erected and maintained by the contractor.

If a partial Notice to Proceed is issued, the contractor shall immediately begin the erection of signs and barricades over the affected portions of the project to the extent necessary to comply with the requirements herein set forth, or herein referred to. When the full Notice to Proceed is issued, barricades shall be erected at the beginning and end of the project, and signing throughout the remainder of the project shall be completed.

If a full Notice to Proceed is issued, the contractor shall immediately begin the erection of appropriate signs and barricades over the entire project.

In no event shall other construction work under this contract begin until signs, barricades and other traffic control devices, as provided above, have been erected and approved.

When all signs to be furnished and erected by the contractor are in place and approved, the Department's district forces will remove or cover any standard signs that are in conflict with the temporary signs.

The engineer shall cooperate with the contractor's representatives in placing of signs, as well as the representative of the Department's District Engineer charged with removing departmental signs. The work shall be performed in an orderly manner so that at all times an adequate number of appropriate signs are in place.

Signing shall remain in place and shall be maintained by the contractor and supplemented by additional signs as may be required throughout the life of the contract.

Signs placed by the contractor shall not be removed until the contract is completed and in no event until Department's forces have properly re-erected standard highway signs along the project. However, it shall be the responsibility of the Department to see that all departmental signs are in place upon completion and acceptance of the project.

Signs, barricades and related devices furnished and placed by the contractor shall, upon removal, remain his property.

On projects where the surface course is constructed with asphaltic concrete or portland cement concrete pavement, the permanent centerline striping shall be completed by the Department's forces prior to the removal of barricades.

713.04 PAVEMENT MARKINGS. The color, width and type of marking shall be in accordance with the Louisiana MUTCD. Temporary centerline and/or lane line markings shall be placed on each lift of asphaltic concrete surfacing subjected to traffic during construction. Temporary markings shall be in place at the end of each day's asphaltic concrete surfacing operations on all lanes that are open to traffic. Roadway centerlines and/or lane lines shall be marked with 3-foot long stripes placed on approximate 40 foot centers. On the final surface, temporary markings shall be placed with

sufficient accuracy to avoid conflicting with permanent striping.

The contractor shall satisfactorily remove all temporary pavement markings by approved methods after completion of permanent striping, at no additional cost to the Department.

713.05 METHOD OF MEASUREMENT.

(a) **Temporary Signs and Barricades:** When the contract does not include a pay item for "Temporary Signs and Barricades," the providing of temporary construction signs, barricades and related devices necessary for the protection of the public will be considered incidental to the work and will not be measured for direct payment.

When a pay item for "Temporary Signs and Barricades" is included in the contract, the furnishing, erecting, maintaining and subsequent removing of all temporary construction signs, barricades and related devices necessary for the protection of the public will be measured on a lump sum basis.

(b) **Temporary Pavement Markings:** When the contract does not include an item for "Temporary Pavement Markings," the providing of these markings will be considered incidental to the work and will not be measured for separate payment.

When the contract includes an item for "Temporary Pavement Markings," these markings acceptably furnished, placed, maintained and subsequently removed will be measured on a lump sum basis.

713.06 BASIS OF PAYMENT. Temporary construction signs, barricades and related devices will be paid for at the contract lump sum price in accordance with the following payment schedule. After initial installation and approval of signs, barricades and related devices, the contractor will be paid 20 percent of the lump sum contract price for the item. For each additional 10 percent of the total contract amount earned, an additional 10 percent of the lump sum contract price for the item may be paid.

Temporary pavement markings will be paid for at the contract lump sum price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
713(1)	Temporary Signs and Barricades	Lump Sum
713(2)	Temporary Pavement Markings	Lump Sum

Section 714

Slab Sodding

714.01 DESCRIPTION. This work consists of furnishing, hauling, planting, fertilizing and liming if required, rolling, watering and maintaining live grass sod, at locations shown on the plans or designated by the engineer.

714.02 MATERIALS. Slab sod shall be composed of either field grown grass or approved nursery grown grass.

Field grown grass sod shall be composed of bermuda grass, carpet grass, or other approved grass native to the work area.

Nursery grown grass sod shall be composed of centipede, tiffway bermuda, nomow bermuda, common bermuda or bahia grass.

Sod shall be free from noxious weeds and other vegetation.

Commercial fertilizer, and agricultural lime, shall conform to Subsections 1017.16 and 1017.17.

Water may be obtained from any source, except brackish or oily water shall not be used.

714.03 GENERAL CONSTRUCTION REQUIREMENTS. Slab sod shall be cut with approved mechanical or manual sod cutters. The designated area shall be mowed when necessary, and the sod shall be cut to a minimum soil depth of 1½ inches for field grown grass and 1 inch for nursery grown grass, and to a uniform width and in convenient lengths for handling. Care shall be exercised at all times to retain the soil on the roots of the sod during excavating, hauling and planting.

Sod which has been cut more than 48 hours before placing shall not be used unless authorized by the engineer.

Sod taken from bare areas that may produce inferior growth will not be accepted.

Any watering required in connection with digging, storing or hauling sod will not be paid for.

714.04 DIGGING AND HANDLING SOD. The contractor may use either hand or machine methods for digging and handling sod.

(a) Hand Method: When sod is cut in the field, it shall be placed flat,

grass side up on boards of convenient lengths and hauled to the planting site with soil still intact. Only one layer of sod shall be placed on each board and such boards shall be of sufficient thickness to prevent unreasonable bending and of sufficient width so that the slabs of sod shall not hang over the edges. The slabs shall be placed closely without leaving unreasonable spaces between them. In no case shall slab sod be loaded in bulk on vehicles or dumped in bulk on the planting site.

(b) Machine Method: The contractor may use mechanical devices to cut, load, haul and plant sod. All sod stacked shall be kept moist and protected from the elements in a manner satisfactory to the engineer. When the machine method is used, final acceptance will not be made until a satisfactory growth of healthy, living, growing grass turf has been obtained.

714.05 PLANTING. All areas to receive slab sod shall be thoroughly scarified and pulverized to a depth of approximately 3 inches and dressed to a reasonable grade. If an item for agricultural lime is included in the contract, the liming shall be done when area is being pulverized. If an item for fertilizer is included in the contract, approximately 90 percent shall be broadcast over the entire area to receive the slab sodding, the remaining 10 percent shall be broadcast over the sod after placing and rolling. Upon delivery to the planting site, the slab sod shall be transferred onto the surface of the soil. The area to be sodded shall be watered as directed. The slabs of sod shall be placed closely, leaving a minimum amount of space between slabs. Slabs which do not fit closely shall be pulled together with suitable tools and pegged when necessary.

714.06 ROLLING. All slab sod shall be rolled as soon after planting as practicable with plain rollers or cultipackers. Where rolling is impracticable, the sod shall be tamped by approved hand methods.

714.07 WATERING. All slab sodding shall be watered as necessary. If nursery grown grass sod is used, particular attention shall be paid to watering.

714.08 EQUIPMENT. All equipment necessary for the satisfactory performance of this work shall be furnished and maintained by the contractor.

714.09 METHOD OF MEASUREMENT.

(a) Slab Sodding: The quantities of slab sodding for payment will be the design areas as specified on the plans and adjustments thereto. The design quantities are based on the surface dimensions of slab sodded areas shown on the plans. The design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

(b) Water: Water will be measured in units of 1,000 gallons in approved tanks used by the contractor.

(c) Fertilizer and Agricultural Lime: Any required fertilizer and agricultural lime will be measured for payment in accordance with Section 718.

714.10 BASIS OF PAYMENT. The accepted quantities of slab sodding and water will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
714(1)	Slab Sodding	Square Yard
714(2)	Water	M Gallons

Section 715

Topsoil

715.01 DESCRIPTION. This work consists of furnishing and placing topsoil on areas as designated on the plans or as directed by the engineer which will be seeded, fertilized and limed (when required) in accordance with Sections 717 and 718.

715.02 MATERIALS. Topsoil shall be approved natural, workable, loamy soil, free of debris, refuse and similar foreign matter, and reasonably free of subsoil, hard lumps, gravel and other such materials. Approved existing topsoil materials within the project construction limits may be used for this work in accordance with provisions of Subsection 104.05.

715.03 EQUIPMENT. All equipment necessary to furnish and place the topsoil in accordance with these specifications shall be furnished and maintained by the contractor.

715.04 CONSTRUCTION REQUIREMENTS. Areas to receive topsoil shall be scarified to a depth satisfactory to the engineer and dressed to grade. If agricultural lime is required, it shall be spread prior to scarifying the areas.

Fertilizer shall be broadcast over the scarified and dressed areas prior to placing topsoil, unless hydroseeding methods are to be used. The topsoil shall be uniformly spread over the areas to a depth of 6 inches and rolled to a uniform surface with a cultipacker or other suitable equipment. Any damage to the completed topsoil shall be satisfactorily repaired prior to beginning seeding operations.

715.05 METHOD OF MEASUREMENT. Topsoil furnished, placed and accepted will be measured by the cubic yard in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

715.06 BASIS OF PAYMENT. The accepted quantity of topsoil will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
715(1)	Topsoil	Cubic Yard

Section 716

Vegetative Mulch

716.01 DESCRIPTION. This work consists of furnishing and placing an asphalt tacked mulch of straw or hay on areas that have been seeded, for protection against erosion.

716.02 MATERIALS.

(a) Mulch: Mulch shall conform to Subsection 1017.19. The contractor shall notify the engineer at least 7 days in advance of commencing operations so that the mulch can be inspected and approved prior to use.

Mulching material shall be delivered to the project in bales of uniform size. Any necessary storage of mulching materials shall be in accordance with Subsection 106.08. Mulch stockpiles shall be suitably protected from the weather.

(b) Asphalt: Asphalt for mulching shall be approved emulsified asphalt conforming to Section 1002.

716.03 EQUIPMENT. All equipment necessary to satisfactorily perform the mulching operations shall be furnished and maintained by the contractor.

716.04 GENERAL CONSTRUCTION REQUIREMENTS. Mulching shall closely follow ground preparation, fertilizing, liming, seeding or combination thereof. All mulch shall be placed with mechanical equipment of a conventional type which will distribute the mulch uniformly by blowing it onto the area. The equipment shall be provided with jet nozzles spaced in the muzzle of the blower, through which the asphalt is ejected simultaneously with the mulch, thus coating the mulch uniformly with a spray of asphalt as the mulch is blown through the nozzle.

Spreading the mulch manually and after-spraying with asphalt will be permitted only in areas which are inaccessible to the equipment or where the asphalt may deface a structure.

716.05 SPREADING RATES. Mulch shall be applied at a rate of 1½ to 2 tons per acre simultaneously with the emulsified asphalt at a rate of 75 to 150 gallons per ton of mulch.

When required, the emulsified asphalt shall be diluted with water in such proportions as is designated.

The specific rates of application of mulch and asphalt shall be as specified by the engineer.

716.06 MANUAL SPREADING. Where manual spreading is permitted, the mulch shall be placed in such a manner that a loose, shredded and fluffy condition will prevail, after which the emulsified asphalt shall be sprayed over the surface of the mulch at the specified rate.

716.07 MULCHING OPERATIONS. Mulching operations shall begin within 36 hours after completion of seeding.

In its final position, the asphalt-tacked mulch shall be loose enough to allow air to circulate, but compact enough to partially shade the ground and reduce the impact of rainfall on the surface of the soil. Mulching shall begin at the top of slopes and extend downward. Particular attention shall be given to the top of cut slopes so that such areas will be covered at the junction with the natural ground. Extensions to the blower pipe shall be supplied where high slopes are encountered that cannot be reached by the blower under normal conditions. Windy conditions will have an effect on the uniformity of final mulch placement, and the contractor will be requied to make adjustments in his operations to obtain uniform spreading.

Care shall be taken not to spray asphalt on structures that are within the mulching area. Any asphalt stains that are unsightly shall be removed and the surface left in a condition acceptable to the engineer.

716.08 METHOD OF MEASUREMENT. Vegetative mulch will be measured by the ton, complete in place and accepted. The weight for measurement will be the product of the number of bales used and the average weight per bale as determined on certified scales provided by the contractor.

Emulsified asphalt placed and accepted will be measured by the gallon at 60°F in accordance with Temperature-Volume Correction Table III in Section 506. No measurement for payment will be made for water used in the emulsion.

716.09 BASIS OF PAYMENT. The accepted quantities of vegetative mulch and emulsified asphalt will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of the emulsified asphalt.

Payment will be made under:

Item No.	Pay Item	Pay Unit
716(1)	Vegetative Mulch	Ton
716(2)	Emulsified Asphalt	Gallon

Section 717

Seeding

717.01 DESCRIPTION. This work consists of preparing seed bed, fertilizing, liming and watering if required, furnishing and sowing grass seed on the areas designated on the plans or as directed.

717.02 MATERIALS. Seed shall conform to Subsection 1017.18.

Commercial fertilizer and agricultural lime shall conform to Subsections 1017.16 and 1017.17.

Water shall conform to Subsection 714.02.

717.03 EQUIPMENT. All equipment necessary to satisfactorily perform the seeding operations shall be furnished and maintained by the contractor.

717.04 SELECTION OF SEED. Prior to planting time, the engineer will contact the Department's roadside development personnel in order to select the varieties of seed to be used on the project as shown in Table I.

717.05 SOIL AREAS. The seed shall be selected for planting on the basis of 5 general soil areas shown as follows:

(1) Alluvial soils of the Mississippi and Red River bottoms.

(2) Mississippi terraces and loessial hill soils.

(3) Coastal plain soils (rolling, hilly and flatwoods areas in central, northern and eastern part of the State).

(4) Coastal prairie soils.

(5) Ouachita River bottom.

717.06 PREPARATION OF SEED BED. The seed bed shall be prepared by breaking, disking, harrowing, blading or other approved methods. The soil shall be thoroughly pulverized to a minimum depth of 3 inches and leveled as directed. All hardpan areas shall be roto-tilled if necessary to insure that the soil is in a condition to receive and sprout seed. If the contract requires topsoil, fertilizer or agricultural lime, they shall be incorporated at this time. The slopes shall then be smoothed to grade and rolled prior to seeding.

717.07 SEEDING. All seeds shall be planted within the date indicated in Table I, unless written permission is obtained for earlier or later plantings.

TABLE I

Mixture	Seed Mixture	Pounds Per Acre	Soil Area	Planting Dates
A	Hulled Bermuda Pensacola Bahia	15 15	1,2,3,5	March thru Sept.
B	Bermuda Carpet	10 20	2,3,4,5	March thru Sept.
C	Hulled Bermuda *Crimson Clover	10 20	1,2,3,5	Feb. thru March
D	Kentucky 31 Fescue Pensacola Bahia	30 10	1,2,3,5	Sept. thru Feb.
E	Kentucky 31 Fescue *Crimson Clover	30 10	1,2,3,4,5	Sept. thru Feb.
F	Kentucky 31 Fescue *Crimson Clover Pensacola Bahia	20 10 10	1,2,3,5	Sept. thru Feb.
G	Hulled Bermuda	30	1,2,3,4,5	March thru Sept.
H	Kentucky 31 Fescue	40	1,2,3,4,5	Sept. thru Feb.
I	*Crimson Clover	40	1,2,3,4,5	Sept. thru Feb.

*Crimson Clover will be inoculated prior to planting with the proper bacterial culture.

The contractor will be allowed to seed the newly disturbed area by the use of a hydroseeder in a slurry using water as a carrying agent. Under this method, the seed, fertilizer and agricultural lime shall be distributed over the area in one operation. The same rates for seed, fertilizer, and agricultural lime will apply as in the conventional method.

717.08 WATERING. After the seed has been planted, the area shall be watered immediately with approved watering tanks unless, in the opinion of the engineer, there is sufficient moisture to eliminate watering. After the initial watering, other waterings shall follow as directed until the project is accepted.

717.09 METHOD OF MEASUREMENT. Seeding will be measured by the pound of seed used in the completed and accepted seeding.

Water, fertilizer and agricultural lime will be measured for payment in accordance with Sections 714 and 718; however, water used in the hydroseeding slurry will not be measured for payment.

717.10 BASIS OF PAYMENT. The accepted quantity of seeding will be paid for at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
717(1)	Seeding	Pound

Section 718

Fertilizer and Agricultural Lime

718.01 DESCRIPTION. This work consists of furnishing and applying commercial fertilizer and agricultural lime on the areas designated on the plans or as directed in accordance with these specifications.

718.02 MATERIALS.

(a) Commercial Fertilizer: Fertilizer shall be an approved brand conforming to the requirements of the Louisiana Department of Agriculture. Fertilizer shall be either 8-8-8, 12-12-12, or 13-13-13, at the option of the contractor, and shall conform to Subsection 1017.16.

(b) Agricultural Lime: Agricultural lime shall conform to Subsection 1017.17. The material may be delivered to the job site either in sacks or bulk.

718.03 EQUIPMENT. All equipment necessary to satisfactorily perform the work shall be furnished and maintained by the contractor.

718.04 APPLICATION.

(a) Commercial Fertilizer: Fertilizer shall be uniformly broadcast over the area to be fertilized by either hand or machine methods. Unless otherwise provided, the approximate rate of broadcast fertilizer per acre shall be as follows:

Type	Pounds Per Acre
8-8-8	1,000
12-12-12	667
13-13-13	615

The rate per acre may be increased or decreased as directed.

Fertilizer shall be applied as indicated in Sections 714, 715 and 717, or as directed.

When fertilizer is applied following surface dressing, it shall be thoroughly incorporated in the soil by light disking or harrowing. Fertilizer may be applied just before final disking or harrowing during the process of surface dressing or, if dressed by hand, it may be applied just before final raking and leveling.

(b) Agricultural Lime: Agricultural lime shall be spread uniformly over the area to be limed at the rate of 2 tons per acre with a spreader. The lime must be applied prior to seeding and may be applied in conjunction with the fertilizer. Several passes may be required to obtain the desired application rate. Soon after application, the entire area shall be disked, harrowed, or rototilled to incorporate the lime or lime-fertilizer into the top 3 to 6 inches of the soil.

(c) Hydroseeding: If hydroseeding methods are used, the contractor will be permitted to include the fertilizer and lime in the seeding slurry for application during the hydroseeding operations.

718.05 METHOD OF MEASUREMENT.

(a) Fertilizer: Fertilizer furnished, applied and accepted will be measured by the pound. The estimated quantity shown in the plans and proposal is based on the use of type 8-8-8 fertilizer. If other types of fertilizer are used, the measured quantities will be multiplied by the following factors to determine the pay quantities:

Type	Factor
12-12-12	1.5
13-13-13	1.625

(b) Agricultural Lime: Agricultural lime furnished, placed and accepted will be measured by the ton.

718.06 BASIS OF PAYMENT. The accepted quantities of fertilizer and agricultural lime will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
718(1)	Fertilizer	Pound
718(2)	Agricultural Lime	Ton

Section 719

Landscaping

719.01 DESCRIPTION. This work consists of furnishing and planting various types and sizes of plant materials in accordance with the plans and these specifications.

719.02 LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC. The contractor shall conduct his operations in accordance with Section 107 and the requirements of the Louisiana Horticulture Law and Regulations.

719.03 EQUIPMENT. All equipment necessary to satisfactorily perform the landscaping work shall be furnished and maintained by the contractor.

719.04 QUALITY AND EXTENT OF WORK. All work shall be done in the manner normally required in good trade and practice of landscaping and the contractor must use proper means to provide that all plant materials, approved by the engineer for planting, shall be dug, loaded, moved, unloaded, planted, fertilized, pruned, watered, and maintained in such a manner as to insure their lives for healthy growth in their new locations.

The contractor shall perform cleanup work in the work areas daily, and periodically throughout the limits of the project, in order to present a neat appearance of the project at all times.

719.05 ASSEMBLY OF PLANT MATERIALS. All plants shall be inspected and approved at the job site by Department personnel before they will be eligible for planting. This approval shall not be misconstrued to mean final acceptance. Plant materials damaged enroute to the planting site will be subject to rejection.

719.06 PLANT MATERIALS.

(a) State and Federal Regulations: All plant material shall be free from injurious insect pests and plant diseases and subject to all regulations of the Federal and State Departments of Agriculture. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the states of origin and destination. The contractor shall obtain the proper certificates for movement of nursery stock intrastate and inter-

state, and shall comply with all other requirements before and during movement or shipment of plants. A valid copy of the certificate of inspection shall accompany each package or carload lot shipped or otherwise delivered.

(b) Plant Names: All scientific and common plant names of the items specified will conform to the edition of Standardized Plant Names, as adopted by the American Joint Committee on Horticulture Nomenclature, that is in effect at the time of the invitation for bids. All plants delivered shall be true to name and legibly tagged as specified hereinbefore. There shall be no substitutions for the kinds, quantities or sizes of the materials specified, unless written permission is obtained from the engineer, and then, only when sufficient evidence has been presented by the contractor that the plant cannot be obtained, permission will be given to substitute only such plants as are equal to or better than the original plants specified.

(c) Grading Standards: Grading of plants shall conform to the "Grades and Standards for Landscape Materials," as prepared by the Louisiana Association of Nurserymen, Inc., in effect at the time of invitation for bids, and to any further contract requirements.

(d) Plant List: A complete list of plants will be shown on the plans in regard to botanical name, common name, quantity, condition, height, caliper, etc. All sizes of stock shown thereon are the minimum acceptable sizes.

(e) Quality and Source of Plant Materials: All plant materials shall be nursery grown, unless written permission is obtained from the engineer to use selected native stock. This permission will be granted only in case the contractor demonstrates that it is impracticable to obtain nursery grown plant material or if, in the opinion of the engineer, selected native stock will be better suited or superior in quality to that obtained from a nursery.

If permission is given to use selected native stock, the engineer will inspect the materials before digging and the contractor shall tag each plant selected (as described hereinbefore) and dig the plants as directed. In the event any selected plant does not show a sufficient root system after being dug, it will be rejected. The handling care and other requirements of collected native plants will be the same as that described for nursery grown stock.

All plants shall be root pruned, heavily caned and typical of the species. They must possess a healthy, normal and fibrous root system of sufficient size to insure plant growth. The branch system shall be of normal development and free from disfiguring knots, sun scald, injuries, abrasions of the bark, dead or dried wood, broken terminal growth or other objectionable disfigurations. All trees shall have reasonably straight trunks and shall be well branched and symmetrical in accordance with their natural habits or growth.

(f) Balled and Burlapped Plants: Plants designated "B & B" condition shall be carefully dug with balls of soil sufficiently large to include enough roots at the sides and the bottom of the plant to insure proper growth. These balls shall be dug by "cutting" and not by "spading out" or "lifting" from the ground. The burlap must be securely fastened around the ball by an approved method, such as pinning with nails or tying with cord. Large balls 1½ feet or more in diameter shall be tied with small rope to insure against settling or cracking. Balled plants must be handled only by the balls of soil.

(g) Container Grown Plant: Container grown stock which has become "potbound" or for which the top system is out of proportion (larger) to the size of the container or has roots growing out of the container will not be acceptable. The stock shall have a fibrous, cohesive root system. Container grown plants shall not be removed from the vessel until just before planting, and all due care shall be exercised to prevent root system damage.

(h) Bare Root Plants: Prepared backfill soil shall be placed in the plant pit to the required minimum depth. Bare rooted plants shall then be placed in the center of the plant pit and the roots properly spread out in a natural position. All broken or damaged roots shall be cleanly cut back to sound root growth.

Backfill soil shall then be carefully worked around and over the roots and thoroughly and properly settled by firming or tamping. Thorough watering or puddling shall accompany backfill around bare root plants. Earth saucers or water basins at least four inches in depth for trees and three inches in depth for shrubs, shall be formed around individual plants with a diameter equal to that of the plant pit.

The prepared backfill soil shall consist of a mixture of topsoil, loam, or selected soil, and peat moss or peat humus. The mixture shall contain four parts topsoil, loam, or selected soil to one part of peat moss or peat humus.

(i) Handling and Storage: During handling and storage, the contractor shall protect the plants from drying out by covering the root system with suitable materials or wetting the foliage if necessary. Balled and burlapped (B & B) materials shall have the earth balls covered with sawdust, woodchips or other suitable materials and kept in a moist condition. Bare root materials in bundles shall have the bundles opened, plants separated, and then heeled-in in trenches. Container grown plants shall be kept sufficiently moist to insure their livability.

(j) Delivery and Receipt of Plant Materials: The contractor shall notify the engineer at least 24 hours before making any delivery of plant material to the project. Each shipment shall be accompanied by an invoice showing the sizes and varieties included in that particular shipment.

(k) Inspection: All plant materials are subject to inspection at any time during the life of the contract by an authorized representative of the Department. Approval of plant material during any of such inspections before or during planting operations, however, shall not be construed as final acceptance of the plants involved.

(l) Rejection of Plant Material: Any plants having any of the following unnatural or objectionable features will be rejected; excessive abrasions of the bark; dried out root system; excessive dead wood; dried up wood; excessive sun scald injuries; undeveloped and weak top or roots or both; crooked or one-sided development of tops; no straight leaders on trees naturally and normally having them; broken or removed leaders; untrue types of sizes; not complying with Federal and State Laws or regulations bearing on inspection and certificates; excessively damaged balls of soil; balls of soil dug from loose soil which could not be expected to properly ball and hold in handling; plants actually dead; and plants not otherwise complying with plant specifications herein.

The rejected material shall be removed from the site and replaced as quickly as possible with new plant material of the same kind, meeting the requirements, at the expense of the contractor.

719.07 CONSTRUCTION METHODS.

(a) Seasonal Operations: Unless otherwise authorized by the engineer in writing, all planting operations shall be performed between November 1 and April 15.

Regardless of the specified planting dates, the work shall be suspended when the temperature is below 25 degrees F, the wind velocity over 25 miles per hour, the natural ground or topsoil is frozen or too wet, or the continuation of prevailing weather would likely cause unsatisfactory results. The contractor shall complete his planting as early as practical in the specified planting season.

(b) Care and Handling of Plants Before and During Planting: The contractor shall, in loading, unloading or handling plants, exercise the utmost care to prevent injuries to trunks, limbs, branches and roots. Immediately following delivery and inspection at the site of the work, all plants must be cared for in approved horticultural manner satisfactory to the engineer. Plants must not be allowed to dry out.

If not immediately planted, balled plants must be adequately protected by covering the balls of soil with soil, sawdust, hay or straw and shall be watered frequently. The solidity of the balled plants shall be carefully preserved. They must not be handled by their tops in lifting, moving or setting, but must be handled at all times by their balls of soil.

(c) Pruning: If necessary, plant material shall be pruned at the site in accordance with standard modern practice. Cuts over 1 inch diameter shall

be painted with an approved tree paint.

(d) Location of Plants: Planting stakes will be set by the engineer at the designated locations of all plants. Each stake will bear an item number or color code as designated by the engineer to coincide with a particular item number.

(e) Planting Pits: Planting pits may be machine or hand dug. Square or circular pits with vertical or slanted sides shall be dug to the dimensions shown in the plan details.

(f) Setting Plants: All plants shall be planted in pits. Deep planting shall be avoided and, unless otherwise specified or directed, all plants shall be set at such level that, after settlement, a normal or natural relationship of the crown of the plant with the ground surface will be established. Each plant to be planted in an individual pit shall be planted in the center of the pit, unless otherwise directed. When balled and burlapped plants are set, topsoil shall be carefully tamped under and around the base of each ball to fill all voids. All plants shall be planted in topsoil which shall be thoroughly settled by watering and tamping as to eliminate settling and leaning of the plant material.

When plants are to be grouped together in a plant bed or in a line approximately 5 feet, or less from each other, the entire area shall be loosened and lumps broken to a minimum depth of 6 inches prior to excavating plant pits.

(g) Topsoil: Topsoil shall be fertile, friable, natural surface soil obtained from a well drained area and free of all stones, brush, weeds, shale, stumps, roots and other organic litter. Topsoil shall have 3 to 20 percent organic matter and an acidity range between pH 5.0 to 8.0 inclusive. Prior to delivery the contractor shall provide a statement regarding the source of the topsoil and shall provide a certified chemical and mechanical analysis made by an approved testing laboratory.

(h) Fertilizer: The contractor shall furnish and place commercial fertilizer (8-8-8) at the rate specified on the plans. The fertilizer shall be spread uniformly on the excavated material in a circle at the outer edge of the planting pit. The fertilizer shall be mixed with the excavated soil before backfilling operations are begun.

(i) Backfilling: All plants shall be plumb and set at the proper depth. Suitable material removed from the excavation shall be mixed with fertilizer and the pit shall be backfilled as directed. Care shall be exercised in placing backfill under the sides and over the ball so as not to disturb same. Backfill to ¾ the depth of the ball on all sides, then water uniformly on all sides of ball in order to eliminate voids and air spaces and allow settlement of the plant. Plants which settle or lean, before or after watering, shall be straightened, raised, replaced or the condition otherwise remedied. Exca-

vated material considered by the engineer to be of unsuitable planting quality shall not be used in the backfill, but shall be replaced with topsoil by the contractor as directed by the engineer, at no additional cost to the Department.

All excavated material not used as a backfill, except soils which contain stones, broken concrete or other foreign matter, shall be spread on areas of the project as directed by the engineer. Soils containing stone, broken concrete or other foreign matter shall be disposed of beyond the highway right-of-way by the contractor to the satisfaction of the engineer.

(j) **Water:** The contractor shall furnish and apply water in sufficient quantities for proper irrigation of the plants. The plants shall be watered during planting operations as required hereinbefore, immediately after planting and at intervals as directed by the engineer until final acceptance.

(k) **Bed Preparation:** When the plans require plants to be located in beds, the planting bed areas shall be scraped, removing all grass, weeds, sticks, stones, bricks, mortar, concrete and other debris. Beds shall then be tilled with a rototiller to the required depth. Peat moss, or an organic matter satisfactory to the engineer, and 8-8-8 fertilizer shall then be added to the soil at the following minimum rates: peat moss or organic matter, 3 pounds per square yard, and fertilizer ½ pound per square yard. After the peat moss and fertilizer have been added, beds shall be tilled again to thoroughly mix all components. Beds shall then be raked smooth and all foreign matter such as dirt lumps, concrete, sticks, grass, mortar, brick, etc., removed from the soil. Finish grade of beds shall be the same as finish grades for adjoining concrete walks. Herbicides used in bed areas shall be approved types.

(l) **Mulching:** Unless otherwise specified, any approved material suitable for mulch may be used. Mulching shall be accomplished as soon as possible after the plants are set. The mulch shall be placed uniformly on all sides of the plant and watered as soon as possible. When plants are planted in a row approximately 5 feet apart or less, the entire row shall be mulched solid. Bed areas shall also be mulched solid.

When pine bark mulch is specified, the mulch shall consist of one inch minimum size chipped pine bark. Excessively decomposed pine bark will be rejected. If fresh pine bark is used, the contractor shall add ½ pound of nitrogen per 10 cubic feet of mulch.

(m) **Weeding:** Weeds shall be kept removed from within the planting basin of each plant including basin walls. The contractor shall mow around all plant materials not planted in beds for a distance of 5 feet. If the contractor decides to use selective herbicide, he will be allowed to do so only after the grass in this 10-foot circle has been cut to a height of not more than 2 inches. These areas must be weeded by hand. Weeding shall be performed as required to maintain a neat appearance and as directed.

719.08 PERIOD OF ESTABLISHMENT AND REPLACEMENTS. Upon the completion of planting all plants, and providing all plants are in place, living and conform to these specifications, this portion of the contract will be given provisional acceptance.

The contractor shall be required to care for all planted areas for a period of establishment, which shall be one full growing season, after the provisional acceptance is made. A growing season shall begin April 16 and extend to October 31. During this period of establishment the contractor shall be required to employ all possible means to preserve the plants in a healthy growing condition. Such plant establishment work shall include cultivation, watering, pruning, controlling insect pests and disease and any other work necessary to insure healthy plant growth. Dead or unsatisfactory plants shall be promptly removed from the project.

The contractor shall contact the engineer every week and outline his activities which he will perform on the project. The contractor will be required to weed in the vicinity of the plants, place mulch and water the plants as required and directed by the engineer. During the period of establishment, the contractor shall maintain a neat and clean appearance of areas affected by operations under this contract at all times.

A semifinal inspection by the contractor and the engineer will be held two weeks prior to the end of the growing season to determine the acceptability of the plants in place and also inventory the number of plants required in the plans and the project specifications. Replacement planting, as may be required, shall be performed in the upcoming planting season.

All dead and unsatisfactory plants shall be replaced in kind, quantity and size with live, healthy plants installed as originally specified. Alternate or substitute varieties of plants shall be used only if approved by the engineer. These replacement plantings shall be made at the contractor's expense. Replacements made at this time will not require a period of establishment.

Upon completion of the said replacements by the contractor and prior to final acceptance of the contract, the contractor shall weed around all plants and remove all discarded materials, rubbish and equipment from within the areas of the highway right-of-way affected by operations under this contract. The said areas shall present a neat and acceptable appearance at the time of final inspection.

A final inspection of all plant material will be held approximately two weeks after the replacement planting has been completed. A final acceptance will be made only if all plants are in place, living and are in conformance with the plans and the project specifications.

719.09 METHOD OF MEASUREMENT. Furnishing and planting of the various types and sizes of plant materials will be measured per each, complete in place and accepted. Unless otherwise specified, no measurement for

separate payment will be made for pit preparation, topsoil, fertilizer, mulching, pruning, watering, guying, weeding, general cleanup of planting areas, care of plants during the period of establishment, or plant replacement.

If the contract includes pay items for bed preparation or pine bark mulch for beds, these items, completed and accepted, will be measured by the square yard; however, if these pay items are not included in the contract, no measurement for separate payment will be made for bed preparation or pine bark mulch for beds.

719.10 BASIS OF PAYMENT. The accepted quantities of bed preparation, pine bark mulch for beds and plant materials of the specified types and sizes will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
719(1)	Plants (Type, Size)	Each
719(2)	Pine Bark Mulch (__'' Depth)	Square Yard
719(3)	Bed Preparation (__'' Depth)	Square Yard

Section 720

Fiber Glass Roving

720.01 DESCRIPTION. This work consists of furnishing and placing fiber glass roving where shown on the plans or as directed by the engineer.

720.02 MATERIALS.

(a) Fiber glass roving: Fiber glass roving shall conform to Subsection 1017.20.

(b) Asphaltic Materials: Asphaltic materials shall conform to Section 1002 and shall be approved grades of either asphalt cement or emulsified asphalt.

720.03 EQUIPMENT. All equipment necessary to satisfactorily perform the work shall be furnished and maintained by the contractor, and shall include the following:

(a) Pneumatic ejector capable of applying fiber glass roving at the rate of 2 pounds per minute (approximately 8 square yards per minute).

(b) Air compressor capable of supplying 40 cfm at 80 to 100 psi. Acceptable air hoses necessary for supplying air to areas not accessible to the compressor.

(c) Asphaltic material distributor with necessary hoses and hand spray bar for working on slopes and other areas not accessible to the distributor.

720.04 CONSTRUCTION REQUIREMENTS. Fiber glass roving shall be applied over the designated area within 24 hours after the seeding operations have been completed.

Fiber glass roving shall be spread uniformly over the designated area to form a random mat of continuous glass fibers at the rate of 0.25 to 0.35 pound per square yard. This rate may be varied as directed by the engineer.

Fiber glass roving shall be anchored to the ground with the asphaltic material applied uniformly over the glass fibers at the rate of 0.25 to 0.35 gallon per square yard. The engineer may require that a light tack coat of asphaltic material be applied to the soil surface prior to applying fiber glass roving. This rate may be varied as directed by the engineer. When required, emulsified asphalt shall be diluted with water in such proportions as is designated by the engineer.

The upgrade end of the lining shall be buried to a depth of one foot to prevent undermining. The lining shall be repaired immediately if damaged. Soil in any damaged areas shall be restored to original grade, refertilized and reseeded if originally specified, all at no additional cost to the Department.

720.05 METHOD OF MEASUREMENT. Fiber glass roving furnished, placed and accepted will be measured by the pound. The number of pounds will be determined as the product of the number of spools or packages of fiber glass roving used and the average weight of the spools or packages. The average weight will be determined by weighing and averaging random samples of not less than 3 percent of the total number of spools or packages required. In no case shall the samples selected be less than three.

Asphaltic material furnished, placed and accepted will be measured by the gallon at 60°F in accordance with the Temperature-Volume Correction Tables in Section 506. No measurement for payment will be made for water used in the emulsion.

720.06 BASIS OF PAYMENT. The accepted quantities of fiber glass roving and asphaltic material will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
720(1)	Fiber Glass Roving	Pound
720(2)	Asphaltic Material	Gallon

Section 721

Asphalt Mulch

721.01 DESCRIPTION. This work consists of furnishing and placing asphalt mulch for erosion control on areas that have been seeded as shown on plans or directed by engineer.

721.02 MATERIALS. Asphalt mulch shall be an approved emulsified asphalt conforming to Section 1002.

721.03 GENERAL CONSTRUCTION REQUIREMENTS. Asphalt mulching shall follow seeding operations as soon as possible. If the areas to receive asphalt mulch have not been sufficiently moistened by rainfall, these areas shall be watered to the satisfaction of the engineer. Asphalt shall be spread with a mechanical spreader equipped with boom or hand spray nozzles.

721.04 SPREADING RATES. Asphalt shall be spread over the surface of the newly seeded areas at the rate of 0.4 to 0.5 gallon per square yard. When required, the asphalt shall be diluted with water in such proportions as designated by the engineer.

721.05 METHOD OF MEASUREMENT. Asphalt mulch furnished, placed and accepted will be measured by the gallon at 60°F in accordance with Temperature-Volume Correction Table III in Section 506. No measurement for payment will be made for water used in the emulsion.

721.06 BASIS OF PAYMENT. The accepted quantities of asphalt mulch will be paid for at the contract unit price, subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
721(1)	Asphalt Mulch	Gallon

Section 722

Field Laboratories

722.01 DESCRIPTION. This work consists of furnishing laboratory buildings at the project site and asphaltic concrete plant sites for the exclusive use of the engineer and other Department personnel in performing the necessary inspection, sampling and testing of the work during construction.

722.02 GENERAL REQUIREMENTS. Field laboratories shall be constructed of wood or metal of an approved type and shall be furnished for the purpose of housing and using testing equipment, keeping records of tests made and making reports. Buildings furnished shall meet the following minimum requirements.

The buildings shall be adequately maintained during their use and may be used for successive phases of a project without additional compensation. The buildings shall remain the property of the contractor and shall be satisfactorily disposed of by him upon completion of the project.

722.03 PROJECT SITE LABORATORY. Field laboratory buildings for general use at the project site shall be movable types which can be placed near the construction areas.

Each building shall have a minimum floor space of 120 square feet. Each building shall be equipped with at least 2 tables or work benches having a minimum size of 30 inches by 48 inches, or as directed. Each building shall have at least one outside door and sufficient windows to provide satisfactory light in the daytime. If the contractor's operations are carried on at night, adequate artificial lighting shall be provided. Roof, floor and walls shall be weathertight. The building shall be moved to various locations on the project as directed by the engineer.

722.04 PLANT SITE LABORATORY. The laboratory for use at each asphaltic concrete plant shall consist of building or room at an acceptable location at the plant site and shall have a minimum floor space of 140 square feet. The laboratory shall be suitably weatherproofed, air conditioned, heated and ventilated; shall contain a sink with running water; and shall be provided with electric lights and power outlets as directed. Electric exhaust fans shall be provided in such size and location to insure continuous removal of fumes resulting from chemicals utilized during testing operations. The laboratory shall be equipped with sturdily constructed benches and

tables as required, shall have at least one outside door, and its contents shall be secured by suitable locks and catches. All keys shall be under the control of the engineer.

722.05 METHOD OF MEASUREMENT.

(a) Project Site Laboratory: Project site laboratories furnished, satisfactorily maintained, moved as directed, and subsequently removed from the project will be measured per each laboratory building.

(b) Plant Site Laboratory: Plant site laboratories provided at asphaltic concrete plants will be considered incidental to the asphaltic concrete work and will not be measured for separate payment.

722.06 BASIS OF PAYMENT.

(a) Project Site Laboratory: The accepted quantity of project site laboratories will be paid for at the contract unit price per each building.

(b) Plant Site Laboratory: No separate payment will be made for asphaltic concrete plant site laboratories, but all costs thereof will be considered as included in the payment for the asphaltic concrete work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
722(1)	Project Site Laboratory	Each

Section 723

Granular Material

723.01 DESCRIPTION. This work consists of furnishing and placing granular material in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical sections shown on the plans or established by the engineer.

723.02 MATERIALS. Granular material shall conform to Subsection 1003.08.

723.03 CONSTRUCTION REQUIREMENTS. The material shall be placed, properly shaped and uniformly compacted so that it conforms to the lines, grades, width, and thickness as shown on the plans; all to the satisfaction of the engineer. The granular material shall not be displaced during subsequent operations.

723.04 DIMENSIONAL TOLERANCES. When net section measurement is specified, the thickness and width of completed granular material courses will be checked for determining acceptance in accordance with DOTD Designation: TR 602. Areas with thickness and width deficiencies in excess of the following tolerances shall be corrected to plan dimensions by furnishing, placing, shaping and compacting additional materials as required at the contractor's expense.

(a) **Thickness:** Underthickness shall not exceed ¾ inch. Overthickness will be waived at no additional cost to the Department.

(b) **Width:** Underwidth shall not exceed 6 inches, except that underwidth on shoulders shall not exceed 3 inches. Overwidth will be waived at no additional cost to the Department.

723.05 METHOD OF MEASUREMENT.

(a) **Net Section:** The quantities of granular material for payment will be the design volumes as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and the compacted thickness of the granular material shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

(b) **Vehicular Measurement:** Granular material will be measured by

the cubic yard in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

723.06 BASIS OF PAYMENT. The accepted quantities of granular material will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
723(1)	Granular Material (Net Section)	Cubic Yard
723(2)	Granular Material (Vehicular Measurement)	Cubic Yard

Section 724

Patching and Widening Pavements

724.01 DESCRIPTION. This work consists of patching and widening existing pavements in accordance with these specifications and in conformity with the lines, grades and typical sections shown on the plans, or as directed by the engineer.

Unless other specified, the contractor shall have the option of using either portland cement concrete or asphaltic concrete for patching and widening.

724.02 MATERIALS. Portland cement concrete shall be Class A or any of the types of pavement concrete, all in accordance with Section 901.

Asphaltic concrete shall be any of the types of asphaltic concrete mixtures, except Type 5B, listed in Section 501; however, the same type mixture shall be used for all patching and widening on the project.

Granular material shall conform to Subsection 1003.08.

724.03 EQUIPMENT. Equipment furnished shall meet the requirements contained in the specifications for the types of material used.

724.04 GENERAL CONSTRUCTION REQUIREMENTS. When through traffic is being maintained, the contractor will be required to complete the replacing of pavement, or to fill and compact any open areas or trenches, before leaving at the end of the day's operations. In no instance may open areas or trenches be left overnight.

The required excavation and compaction of the subgrade shall be in accordance with the plans, or as directed by the engineer. The subgrade shall be compacted uniformly.

The existing surfacing and excess excavation that is removed, unless otherwise directed by the engineer, shall be disposed of beyond the limits of the right-of-way by the contractor.

724.05 PATCHING AND WIDENING WITH PORTLAND CEMENT CONCRETE. Patching and widening with portland cement concrete shall conform to Section 601, except that the contractor shall have the option of using either machine or hand finishing methods. If a granular material subbase is specified, the granular material shall be placed in accordance with Section 723.

724.06 PATCHING AND WIDENING WITH ASPHALTIC CONCRETE. The contact surfaces of existing pavement shall be cleaned and painted with a thin uniform coating of asphaltic tack coat before the asphaltic concrete is placed against them.

The spreading, finishing and compaction of asphaltic concrete shall be such that the surface of the mixture, after compaction, shall be reasonably smooth and level with, or slightly above, the edge of existing pavement. The cross slope shall be in reasonable conformity to that shown on the plans or specified by the engineer. The average densities for the type mix furnished shall be the minimum density specified for traffic lanes in Subsection 501.22(b). Sampling and testing for density shall be of the top 4 inches of the finished sections.

To provide lateral support for widening material, the contractor will be permitted to construct a temporary berm of excavated material against the outside edge of the widening strip prior to rolling.

724.07 METHOD OF MEASUREMENT.

(a) **Patching:** Patching existing pavement will be measured by the square yard. Areas to be measured shall be the actual areas of existing pavement removed and replaced with new portland cement concrete pavement or asphaltic concrete pavement, as the case may be.

Any required excavation in connection with patching operations will not be measured.

(b) **The quantities of widening** for payment will be the design areas as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, or if plan errors are proven, or if design changes are made. The design quantities are based on the horizontal dimensions shown on the plans. Unless otherwise provided, all required excavation, removal of existing pavement and base course, asphaltic tack coat and disposal of removed materials will be considered incidental to the work and will not be measured for separate payment. No measurement for payment will be made for widening placed outside the dimensions shown on the plans or established by the engineer.

724.08 BASIS OF PAYMENT. The accepted quantities of completed patching and widening of existing pavements will be paid for at the contract unit prices per square yard, subject to the following provisions.

(a) **Portland Cement Concrete:** Portland cement concrete patching and widening will be paid for on a lot basis. A lot will be a completed section or an identifiable pour that is completed in one day.

Two random batches shall be sampled for each lot, and 3 cylinders molded for each batch. The 6 specimens per lot will be tested for compressive strength in 28 to 31 days. In the event of sudden cessation of operations, a minimum of 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be as specified in Subsection 601.23(b).

(b) Asphaltic Concrete: Asphaltic concrete patching and widening will be subject to the price adjustment provisions of Section 501 for deficiencies in Marshall stability, roadway density and aggregate gradation; except that price adjustments for roadway density will be based on the average of each day's samples. One sample will be taken per 100 tons (or portion thereof) per day up to a maximum of 5 samples per day.

(c) Asphaltic Materials: In addition to price adjustments for asphaltic concrete mixtures, the asphaltic concrete patching and widening will be subject to price adjustments in accordance with Section 1002 for specification deviations of the asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
724(1)	Pavement Patching	Square Yard
724(2)	Pavement Widening	Square Yard

Section 725

Temporary Detour Roads and Bridges

725.01 DESCRIPTION. This work consists of furnishing, constructing, maintaining and subsequently removing temporary detour roads and bridges at the locations shown on the plans or as directed, and in conformance with plan details and these specifications.

The plan details and specified materials for temporary detour roads and bridges indicate the minimum requirements. Approved equal designs and materials may be used at the option of the contractor.

725.02 MATERIALS.

(a) Detour Roads: All materials for detour roads shall conform to the applicable Sections of Part X.

(b) Detour Bridges: All timber furnished shall be sound, new or used, treated or untreated. Splits, rot, unsound knots or other defects which, in the opinion of the engineer, materially affect the strength of the timber will not be permitted. All timber used in temporary bridging shall conform to species, grade and stress rating requirements of Subsection 1014.01.

Piles shall be pine, fir, cypress or oak and of any grade which will satisfactorily withstand driving and shall be reasonably straight. All lumber and piling, in addition to meeting requirements herein, shall be satisfactory to the engineer. Peeling of bark from piles will not be required.

725.03 CONSTRUCTION REQUIREMENTS.

(a) General: The contractor shall perform all necessary additional clearing and grubbing, and provide all necessary temporary fencing and temporary culvert pipes for the detours. Adequate construction signs and warning devices shall be placed for the detours prior to being opened to traffic. The contractor shall maintain detours in a condition satisfactory to the engineer at all times.

(b) Detour Roads: The contractor shall furnish all embankment material for detours and shall compact embankments by approved methods to the satisfaction of the engineer. If embankment is placed against slopes of existing embankments, the contractor shall remove from such slopes all grass, weeds, trash, bushes and other objectionable material and shall plow slopes so as to form steps.

Base and surfacing construction shall be performed in accordance with the requirements of applicable Sections of these specifications.

Temporary pavement markings conforming to Subsection 1015.08 shall be placed in accordance with the Louisiana MUTCD on all detours that are surfaced with asphaltic concrete or portland cement concrete, and these markings shall be in place at the time the detour is opened to traffic.

(c) Detour Bridging: Temporary bridge lengths shown on the plans are approximate, and the lengths to be constructed will be determined during construction by the engineer. The contractor will not be permitted to post the temporary bridge against passage of loads up to and including the maximum legal load. The temporary bridge construction shall be performed in accordance with the requirements of applicable Sections of these specifications.

725.04 REMOVAL OF DETOURS. Upon completion of the permanent construction and diversion of traffic thereto, the contractor shall remove the detour roads and bridging, and all temporary fencing and culvert pipes, and eliminate all construction scars.

Temporary bridging shall be removed in accordance with Subsection 202.03. All removed bridge materials, temporary fencing and temporary culvert pipes shall remain the property of the contractor and shall be disposed of outside the right-of-way. Detour embankment, base and surfacing materials shall also be disposed of outside the right-of-way, unless reuse of these materials on the project is permitted.

725.05 METHOD OF MEASUREMENT.

(a) Detour Roads: Temporary detour roads will be measured either by the linear foot or square yard, as specified, in accordance with the following provisions.

(1) Linear Foot: Measurement will be made along the centerline of detour roads. On detours with temporary bridging, measurement will be made between the edge of surfacing to the temporary bridging. On detours without temporary bridging, measurement will be made between the edges of the surfacing.

(2) Square Yard: Measurement will be made along the surface of the completed detour road surfacing.

(b) Detour Bridging: Temporary detour bridging will be measured by the linear foot along the centerline of completed bridging in accordance with the following:

(1) If constructed in accordance with the design shown on the plans, measurement will be made from beginning to end of bridging, as shown on the plans.

(2) If constructed in accordance with a design other than as shown on

the plans, the length for measurement shall not exceed the length required for the design shown on the plans.

(c) Incidentals: Any required additional clearing and grubbing, temporary fencing, temporary culvert pipes and temporary pavement markings will be considered as incidental to the work and will not be measured for separate payment.

725.06 BASIS OF PAYMENT. The accepted quantities of temporary detour roads and bridging furnished, constructed, maintained and subsequently removed will be paid for at the respective contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
725(1)	Temporary Detour Roads	Linear Foot, Square Yard
725(2)	Temporary Detour Bridging	Linear Foot

Section 726

Bedding Material

726.01 DESCRIPTION. This work consists of furnishing and placing bedding material to form a suitable foundation for drainage structures in accordance with these specifications and in reasonably close conformity with the lines, grades and sections shown on the plans or established by the engineer.

Unless otherwise specified, bedding material may be any of the types of material listed herein at the option of the contractor. Unless otherwise approved in writing by the engineer, the same type material shall be used throughout the project.

726.02 MATERIALS. Materials shall conform to the following Subsections.

Sand Clay Gravel	1003.05(d)
Shell and Sand	1003.05(e)
Crushed Stone with Binder	1003.05(b) and (c)

The materials shall be properly proportioned and mixed prior to being placed in the foundation.

726.03 PLACEMENT OF BEDDING MATERIAL. The material shall be placed, uniformly compacted and properly shaped, to form a uniform foundation for the structure to the satisfaction of the engineer.

The required excavation below the established grade of the structure for placement of bedding material, shall be disposed of in accordance with Section 203.

A layer of approved compacted impervious material approximately 12 inches thick shall be placed at structure ends for protection against erosion when aggregate is exposed.

The contractor shall satisfactorily dispose of all excess excavated material.

726.04 METHOD OF MEASUREMENT. The bedding material, including impervious material, completed and accepted, will be measured by the cubic yard (net section). The length will be measured horizontally along the structure centerline to the theoretical points established by the plans for bedding material. The width will be measured horizontally to the theoretical

points established by the plans. The depth shall be the actual depth established by the engineer below the established grade line as shown on the plans and determined by the engineer.

All necessary excavation and disposal of excess excavated materials will be considered incidental to the work and will not be measured for separate payment.

726.05 BASIS OF PAYMENT. The accepted quantities of bedding material will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
726(1)	Bedding Material	Cubic Yard

Section 727

Mobilization

727.01 DESCRIPTION. This work consists of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the project site; the establishment of all offices, buildings and other facilities necessary for work on the project and the costs of bonds and any required insurance, and any other preconstruction expense necessary for the start of the work, excluding the cost of construction materials.

727.02 BASIS OF PAYMENT.

(a) When the contract does not include a pay item for mobilization, all preconstruction expenses incurred by the contractor in connection with mobilization will be considered incidental to the work and no direct pay will be made therefor.

(b) When the contract contains a pay item for mobilization, payment will be made at the contract lump sum price, subject to the following provisions.

Partial payments for mobilization will be made in accordance with the following schedule up to a maximum of 10 percent of the original total contract amount, including this item, and payment of any remaining amount will be made upon completion of all work under the contract.

Percent of Total Contract Amount Earned	Allowable Percent of the Lump Sum Price for the Item
1st Partial Estimate	25
10	50
25	75
50	100

No price adjustments will be made for this item due to changes in the work in accordance with Section 109, and any increased mobilization costs incurred by the contractor due to additional work occasioned by such changes will be considered incidental to the additional work.

If the contract is cancelled by the Department, the contractor will be paid

for the actual cost incurred for mobilization at the time of cancellation, which cost will not exceed the total amount bid under the mobilization item.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the contract.

Payments will be made under:

Item No.	Pay Item	Pay Unit
727(1)	Mobilization	Lump Sum

Section 728

Jacked or Bored Pipe

728.01 DESCRIPTION. This work consists of furnishing and installing pipe in embankments at the locations shown on the plans by jacking or boring in accordance with these specifications.

728.02 MATERIALS. The pipe shall conform to Subsection 701.02 or shall be as specified in the plans or project specifications.

728.03 CONSTRUCTION REQUIREMENTS. In general, pipes of 30-inch diameter and greater shall be jacked, and pipes of less than 30-inch diameter shall be bored.

The work shall begin at the outfall end of the pipe whenever possible. In the event the grade at the jacking or boring end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the operations and for placing the joints of pipe. Adequate sheeting and bracing shall be provided to prevent earth caving.

For pipe with bell joints, if the outside diameter of the pipe bell exceeds the outside diameter of the pipe barrel by more than 1 inch, the pipe shall be either cased or pressure grouted for its full length. The casing shall be an approved type and size, and shall be furnished and installed by the contractor in accordance with these specifications. Pressure grouting shall be performed with approved materials placed by approved methods.

The method used shall be such as not to weaken or damage the embankment. The contractor shall furnish to the engineer for approval a plan showing his proposed method of procedure, including the backstop or jacking frame arrangement, pipe guides, positions of jacks, jacking head, etc. Approval of this plan shall not relieve the contractor from his responsibility to obtain the desired result.

(a) **Jacking:** Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided in sufficient numbers to overcome the resistance expected to be encountered. In operating the jacks, even pressure shall be applied to all jacks and shall be transmitted to the pipe end through the use of a properly designed jacking head. The jacking head shall be so designed that the pressure is uniformly applied around the ring of the pipe. The backstop or jacking frame shall be adequate to resist the pressure of the

jacks under load. The pipe shall be set on guides, properly fastened together to support the pipe and to direct it in the right direction and at the correct grade.

Material shall be excavated just ahead of the pipe and shall be removed through the pipe. Excavation shall not extend more than 2 feet beyond the forward end of the pipe, and if the character of the embankment material dictates, the distance shall be reduced as is necessary to prevent the embankment from being damaged.

The excavation shall be done on the under side of the pipe, for at least ⅓ circumference of the pipe, to conform to the contour and grade of the pipe. A clearance of not more than 2 inches may be provided for the upper ½ of the pipe and shall be tapered off to zero at the point where the excavation conforms to the contour of the pipe.

At the option of the contractor, a steel cutting edge may be used around the forward end of the pipe. The cutting edge shall be so constructed that it will fit and will transmit pressures uniformly around the ring of the pipe.

Once begun, the jacking shall continue without interruption, insofar as is practicable, to prevent the pipe from becoming firmly set in the embankment.

The pipe shall not vary laterally nor vertically by more than 1 inch in 10 feet from the line and grade established by the engineer. Any variation shall be regular, and no abrupt changes in direction will be permitted. Any pipe damaged or misaligned in the jacking operations shall be removed and replaced by the contractor at his expense.

(b) Boring: All boring shall be done mechanically and shall be done using a pilot hole of approximately 2 inches in diameter. The pilot hole shall extend through the embankment and shall be checked for line and grade before boring begins. Variations from line and grade shall not exceed those specified for jacking. The pilot hole shall serve as the centerline of the larger diameter hole to be bored.

The use of water and other fluids in connection with the boring operation will be permitted only to the extent necessary to lubricate the cuttings. Jetting will not be permitted.

In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of highgrade carefully processed bentonite may be used to consolidate cuttings of the bit, to seal the walls of the hole, and to furnish lubrication for subsequent removal of cuttings and installation of the pipe thereafter.

Overcutting in excess of 1 inch shall be remedied by pressure grouting the entire length of the installation.

Pipe placed as specified herein shall be joined as specified under Section 701.

728.04 METHOD OF MEASUREMENT. The quantities of jacked or bored pipe for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. All required excavation, sheeting, bracing, falsework, casings and grouting will be considered incidental to the work and will not be measured for separate payment.

728.05 BASIS OF PAYMENT. The accepted quantities of jacked or bored pipe will be paid for at the contract unit price per linear foot.

Payment will be made under:

Item No.	Pay Item	Pay Unit
728(1)	Jacked or Bored Pipe (size, type, class or thickness)	Linear Foot

Section 729

Traffic Signs and Devices

729.01 DESCRIPTION. This work consists of furnishing and installing traffic signs, dead end road installations, markers and delineators, together with accessories, posts and overhead spans of the designated materials, sizes, shapes, weights and designs in conformity with the requirements shown on the plans and contained in these specifications.

In general, the work and materials shall meet the requirements of the Louisiana MUTCD as modified by these specifications or as shown on the plans.

Signs shall be fabricated in a properly equipped plant, and contractor shall show evidence of successful experience in fabrication and erection of quality reflectorized multipanel highway signs.

When lighting of signs is required by the plans, the sign lighting system shall be furnished and constructed in accordance with Section 730.

For the purpose of these specifications the term "legend" shall be understood to mean the border strip and all letters, numerals and symbols which convey the message on signs.

729.02 GENERAL REQUIREMENTS. The contractor shall have the option of furnishing either steel or aluminum signs and supports, except that signs for overhead mountings shall be aluminum. Before beginning work, the contractor shall notify the engineer in writing as to what combination of signing materials he proposes to furnish on this project, and the same combination of signing materials shall be used throughout the project.

The contractor shall furnish fabrication and erection drawings of overhead sign structures, both ground mounted and structure mounted, and sign face details not provided by the Department, all in accordance with Subsection 801.03. Approval of sign face details must be given before approval of sign structure drawings can be made. Fabrication or construction will not be started until drawings have been approved and distributed.

729.03 MATERIALS. All materials shall conform to Parts IX and X, and specifically as follows:

(a) General Requirements: All materials shall be of a new stock and shall be the product of a reputable manufacturer.

The contractor shall furnish samples of the materials specified by the Department's Materials Sampling Manual for testing and any additional samples deemed necessary by the engineer. Certificates of analysis specifying mechanical and chemical properties of the aluminum and ferrous metals may be submitted for approval in lieu of furnishing the samples.

Welding of aluminum alloys and ferrous metals shall conform to Section 815.

(b) Sign and Marker Sheeting: Sheeting material for fabrication of sign panels, delineators, barricades and other markers shall conform to Section 1015.

Reflective sheeting material shall be either Type I, Enclosed Lens Material, or Type II, Encapsulated Lens Material, as specified.

(c) Ferrous Metal: Ferrous metals used in sign construction shall conform to Section 1015. Reinforcing steel shall conform to Section 1009.

All ferrous metal, except reinforcing steel and sheet steel, shall be galvanized in accordance with Section 811.

(d) Aluminum: Aluminum alloys used in sign construction for structural members, sheeting and panels shall conform to Section 1015.

(e) Fittings: Structural bolts, nuts and washers and miscellaneous hardware shall conform to Subsection 1015.03.

(f) Guard Rail: Guard rail materials for dead end road installations shall conform to Section 1010.

(g) Timber: Piling and planks for barricades used in dead end road installations shall be treated timber conforming to Section 1014.

729.04 FABRICATION OF SIGN PANELS AND MARKERS.

(a) General: Signs and markers shall be fabricated in accordance with the plan details, the Louisiana MUTCD and the project specifications.

The completed signs shall show careful finished workmanship in all particulars. They shall be free from cracks, wrinkles, blisters and other blemishes.

(b) Special Requirements:

(1) Unless otherwise permitted by the engineer, metal fabrication including shearing, cutting and punching of holes shall be completed prior to surface treatment of metal and application of sheeting. Metal panels shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication. The surface of all sign panels shall be flat.

(2) To insure a plane surface on the sign face, splice plates joining sign panels shall not extend behind horizontal sills.

(3) The aluminum sheeting shall be 0.080 inch nominal thickness conforming to ASTM Designation: B 209, Alloy 6061-T6.

(4) Galvanized steel sheeting shall be 0.105 inch nominal thickness conforming to Subsection 1015.03.

(c) Surface Treatment of Metal:

(1) Aluminum Signs:

a. Degreasing: Required on sheet aluminum and extrusions:

1. Vapor Degreasing by total immersion of the sign in a saturated vapor of trichlorethylene or perchlorethylene. Trademark printing should be removed with lacquer thinner or controlled alkaline cleaning system.

2. Alkaline Degreasing: Signs shall be immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications.

Immersion time shall depend upon the amount of contaminants present and thickness of metal.

b. Etching: Required only on sheet aluminum.

1. Acid Etch: Etch well in a 6 to 8 percent phosphoric acid solution at 100°F, rinse thoroughly with running cold water and may be followed by hot water tank rinse.

2. Alkaline Etch: Etch well the precleaned aluminum surface in an alkaline etching material controlled by titration; use time, temperature and concentration specified by the solution manufacturer. Rinse thoroughly. Remove smut with an acidic, chromium compound type solution as specified by the solution manufacturer and then thoroughly rinse.

c. Drying: Dry panels by use of a forced hot air drier. Metal shall be handled by approved methods or clean canvas gloves between cleaning and etching operations and the application of sheeting. There shall be no opportunity for metal to come in contact with greases, oils, or other contaminants prior to the application of sheeting.

(2) Steel Signs: Sign blanks or panels shall be given a preliminary cleaning by immersing in a tank containing a buffered alkaline cleaning solution, controlled and titrated according to the manufacturer's specifications. Immersion time shall depend upon the amount of contaminants and the gage of the metal. This shall be followed by a thorough rinse with clean, running cold water. After preliminary cleaning, the sign blank or panel shall be dipped in a mild chromic acid solution as recommended for the final rinse after phosphating zinc. The panels shall then be dried by the use of warm forced air.

Metal shall be handled by approved methods or clean canvas gloves between cleaning and surface preparation and application of sheeting. There shall be no opportunity for metal to come in contact with greases, oils or other contaminants prior to application of sheeting.

(d) Paint Screening Process: Paint screening of sign faces shall be in accordance with Subsection 1015.07 and these requirements.

Screening shall be by direct or reverse silk screen methods accomplished in the manner specified by the sheeting manufacturer. Screening on the sheeting may be accomplished either before or after application of the sheeting to the base panels.

(e) Applying Sign Face and Legend Sheeting: Application of sign face and legend sheeting material shall be in accordance with the recommendations of the manufacturer of the materials and subject to the approval of the engineer. Unless otherwise approved in writing by the engineer, the reflective sheeting shall be applied to the metal panels in such manner that there are no horizontal splices.

(1) Sign Face Background: Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the manufacturer.

Sign faces comprising two or more pieces or panels of reflective sheeting must be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance, both day and night. Alternate, successive width sections of either sheeting or panels must be reversed and consecutive to insure that corresponding edges of reflective sheeting lay adjacent on finished sign. Non-conformance may result in non-uniform shading and undesirable contrast between adjacent widths of applied sheeting which will not be acceptable.

Reflective sheeting splices and sign edges shall be sealed in accordance with the manufacturer's recommendation.

(2) Legend: Legend shall be of the shape, size, dimension and stroke as specified in the Louisiana MUTCD and of the type specified on the plans. Legend shall be applied by one of the following methods:

1. Direct Applied
2. Demountable
3. Screened

a. Direct Applied Legend: The legend shall be adhesive coated reflective sheeting as specified under Subsection 1015.05. The legend shall be applied in such manner to provide a wrinkle-free surface.

b. Demountable Legend: The legend shall be adhesive coated reflective sheeting as specified under Subsection 1015.05. The sheet-

ing shall be permanently adhered to a flat aluminum backing. Legend shall be mounted on 0.032 inch thick aluminum sheet conforming to ASTM Designation: B 209, Alloy 3003 H-14. Aluminum shall be properly degreased and etched or treated in accordance with Heading (c) herein. The legend shall be attached to the sign face in such manner as to provide a smooth flat surface. Rivets that may prohibit such application shall be removed and replaced through the legend or the legend may be raised by means of approved spacers.

The legend shall show careful workmanship and be clean cut, sharp, uniform breadth and width of stroke, and have essentially a plane surface. The legend shall be packaged in such manner as to assure arrival in an undamaged condition, and shall not become wet in storage or shipment.

c. **Screened Legend:** Legend shall be applied to sign faces by an approved screening process in accordance with the recommendations of the reflective sheeting manufacturer. Screen pastes shall be those compatible with the reflective sheeting used and shall not reduce reflectivity properties of the reflective sheeting less than those values of the screened colors shown under Subsection 1015.05, Table XII. The completed screen surface shall be uniform in color, have sharp edges, be free of bubbles and blemishes, streaks or livered areas, and show good quality workmanship.

(f) Hazard Markers, Milepost Markers and Delineators:

(1) Hazard Markers: Hazard markers shall be silver reflectorized material in accordance with Subsection 1015.05 and low gloss black nonreflectorized material in accordance with Subsection 1015.06 or 1015.07 mounted on aluminum sheeting of 0.080 inch nominal thickness.

(2) Milepost Markers: Milepost markers shall be reflectorized green background sheeting and reflectorized silver white numerals in accordance with Subsection 1015.05 mounted on aluminum sheets of 0.080 inch nominal thickness or galvanized steel sheets of 0.105 inch nominal thickness.

(3) Delineators: Delineators shall be Type II reflective sheeting (silver, red or yellow, as specified) conforming to Subsection 1015.05 mounted on aluminum sheeting of 0.080 inch nominal thickness, and punched or sheared to the specified dimensions.

(g) Packaging: Before being packed, signs shall be allowed to stand for at least 12 hours after completion of paint screening. Signs shall be slip sheeted and packed in such manner as to insure their arrival at destination in an undamaged condition. Packaged signs shall not become wet in storage or shipment.

729.05 GENERAL CONSTRUCTION REQUIREMENTS. If removal of existing signs is required, the contractor's sign removal operations shall be coordinated as directed with the new sign erection to provide adequate and appropriate signing in place at all times.

(a) Construction Stakes: Sign support locations shall be determined and staked by the engineer. Locations which are obviously improper because of topography, existing appurtenances or other conflicting conditions will be adjusted to the closest more desirable location. The contractor will be required to determine elevations for post length determinations at the established sign support location.

Required information relating to lines and grades will be furnished by the Department; however, the contractor will be responsible for orientation, elevation, offset and leveling of all signs erected.

(b) Sign Positioning: Unless otherwise shown on the plans or in the Louisiana MUTCD sign positioning shall be as stated herein.

The glossy surface on sign faces may produce specular reflection. Signs shall be positioned to eliminate or minimize specular reflection.

(1) Overhead Signs: Signs shall be erected so that the sign face is tilted back 2 or 3 degrees (approximately 1 inch in 2 feet) from the vertical and at right angles to the road, unless otherwise directed by the engineer.

(2) Road Edge Signs: All road edge signs shall be erected with sign faces vertical. Sign faces located not more than 15 feet from the edge of the travel lane shall be placed at a 93-degree angle from the center of the travel lane, and sign faces located more than 15 feet from the edge of the travel lane shall be placed at an 87-degree angle from the center of the travel lane. Where lanes divide or on curves or grades, sign faces shall be oriented so as to be most effective both day and night and to avoid the possibility of specular reflection.

(3) Vertical and Horizontal Clearances: In ground installations, signs shall be erected at a minimum height of 6 feet above the edge of the pavement to the bottom of the signs. If, however, a secondary sign is mounted below another sign, the secondary sign shall be at least 4 feet above the level of the pavement edge. Overhead sign mountings shall provide a minimum clearance of not less than 17 feet over the entire width of the pavement and shoulders.

The minimum horizontal clearance from edge of roadway to any ground sign or the nearest vertical member of an overhead sign structure shall be in accordance with current safety standards as shown on the plans or as directed by the engineer.

729.06 EXCAVATION AND BACKFILL. The contractor shall per-

form all excavation for sign installation to the levels and dimensions shown on the plans, or as directed by the engineer. Excavation and backfill shall be made to neat lines and shall be performed in accordance with Section 802.

729.07 FOOTINGS. Foundation piles, concrete, reinforcing steel and anchor bolt assemblies shall conform to Sections 804, 805, 806 and 807.

The engineer will cooperate with the contractor in determining elevations of the tops of footings.

Unless otherwise specified, posts for ground mounted delineator, hazard marker and milepost assemblies shall be driven; no footings will be required.

729.08 ERECTION OF SIGNS. Erection of signs shall be performed in accordance with the plans and these specifications, to the satisfaction of the engineer.

After installation of signs is complete, they shall be inspected at night by the engineer. If specular reflection is apparent on any sign, its positioning shall be adjusted by the contractor to eliminate this condition.

729.09 ERECTION OF DELINEATOR, HAZARD MARKER AND MILEPOST ASSEMBLIES. The location of each type of these assemblies shall be as shown on the plans, specified in the Louisiana MUTCD, or as directed by the engineer. Unless otherwise specified, they shall be placed 2 feet beyond the outer edge of the roadway shoulder, or 2 feet beyond the face of the curb, or in the line of the guard rail, as the case may be.

Structure mounted assemblies shall be installed in accordance with plan details. Posts for ground mounted assemblies shall be driven with a suitable protective driving cap. The post shall be vertical.

729.10 DEAD END ROAD INSTALLATIONS. Dead end road installations shall be of the specified type and shall be located as shown on the plans. Timber barricade type installations shall be constructed in accordance with the requirements of this Section and Section 812. Timber piling shall be set in full depth holes and backfilled as directed or either driven to the required depth. Steel posts for other type installations shall be driven with a suitable protective cap. Piles and posts shall be vertical. Guard rail shall be constructed in accordance with Section 704.

729.11 METHOD OF MEASUREMENT.

(a) Sign Faces: The quantities for payment will be the design areas of sign faces as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Material used in blanks and backing incidental to the sign face will not be measured for separate payment.

In determining the area of sign faces no deductions are made for corner radii or mounting holes. The area of octagonal signs, U.S. shields, and

Interstate shields are computed as the area of its smallest rectangle or square. The area of triangular signs are computed as the area of the triangle.

(b) Post Mountings: Post sign mountings, including break-away supports, of the size and shape specified will be measured per each post. Each post of a multiple post mounting will be counted.

(c) Overhead Mountings: Overhead sign mountings of the span and type specified will be measured per each structure.

(d) Delineator, Hazard Marker and Milepost Assemblies: Each delineator, hazard marker and milepost assembly furnished will be measured, per each unit.

(e) Dead End Road Installations: Dead end road installations of each specified type will be measured per unit, complete in place and accepted.

(f) Footings: Concrete footings for overhead sign mountings will be measured per each footing, completed and accepted. Footings and aprons for post sign mountings will be considered as incidental to the mounting and will not be measured for separate payment.

729.12 BASIS OF PAYMENT.

(a) Sign Faces: The accepted quantities of sign faces will be paid for at the contract unit price per square foot, which includes furnishing, fabricating and erecting the signs and furnishing all necessary attaching devices.

(b) Post Mountings: The accepted quantities of post sign mountings will be paid for at the contract unit price per each, which includes furnishing, fabricating and erecting the support complete, ready for affixing the signs, and also includes all required excavation, concrete and reinforcement for footings and aprons for the sign mounting.

When the contract item denotes a steel post support size the contractor has the option of furnishing the acceptable aluminum post alternate when the requirements of Subsection 729.02, concerning options, are met.

(c) Overhead Mountings: The accepted quantities of overhead sign mountings will be paid for at the contract unit price per each, which includes furnishing, fabricating and erecting the structure complete and ready for affixing the signs.

(d) Delineator, Hazard Marker and Milepost Assemblies: The accepted quantities of delineator, hazard marker and milepost assemblies will be paid for at the unit prices per each which i ludes posts.

(e) Dead End Road Installations: The accepted quantities of dead end road installations will be paid for at the contract unit price per each installation, which includes piling, posts, barricades, sign materials, reflectors, and any required guard rail.

(f) **Footings:** Footings for overhead sign mountings will be paid for at the contract unit price per each footing, which includes all required excavation, piling, concrete, reinforcing steel, anchor bolt assemblies and backfill.

Payment will be made under:

Item No.	Pay Item	Pay Unit
729(1)	Sign (Type A)	Square Foot
729(2)	Sign (Type B)	Square Foot
729(3)	Sign (Type C)	Square Foot
729(4)	Sign (Type D)	Square Foot
729(5)	Sign (Type E)	Square Foot
729(6)	Sign (Overhead Mounted)	Square Foot
729(7)	Mounting (_____Size Post)	Each
729(8)	Mounting (Overhead Truss) (Ground Mounted)	Each
729(9)	Mounting (Overhead Truss) (Structure Mounted)	Each
729(10)	Mounting (Overhead Cantilever) (Ground Mounted)	Each
729(11)	Mounting (Overhead Cantilever) (Structure Mounted)	Each
729(12)	Delineator Assembly (Ground Mounted)	Each
729(13)	Delineator Assembly (Structure Mounted)	Each
729(14)	Hazard Marker Assembly	Each
729(15)	Milepost Assembly (Ground Mounted)	Each
729(16)	Milepost Assembly (Structure Mounted)	Each
729(17)	Dead End Road Installations (Type)	Each
729(18)	Footings for Overhead Mounting (Type)	Each

Section 730

Electrical Systems

730.01 DESCRIPTION. This work consists of furnishing and installing all electrical equipment, apparatus, conduit, wire, junction boxes, secondary power control units, transformers, control stations and all incidentals necessary for complete electrical control and power systems for buildings, roadway and structure lighting, sign lighting and other electrical systems, other than for movable bridges.

The work also includes the furnishing and installing of all electrical equipment and materials required to connect to the electrical system all other appurtenances not classified as electrical equipment such as air conditioning equipment and controls, thermostats, pumps, etc.

The installation shall be carried out in conformity with all requirements stated or implied in plans and specifications, and upon completion shall present a neat and finished appearance. All work and materials shall be subject to inspection at all times.

730.02 GLOSSARY OF TERMS.

AA	Aluminum Association
IEEE	American Institute of Electrical and Electronics Engineers
AWG	American Wire Gage
EIA	Electronic Industries Association
IES	Illuminating Engineering Society
IPCEA	insulated Power Cable Engineer's Association
MSG	Manufacturer's Standard Gage
NEC	National Electrical Code
UL	Underwriters Laboratories, Inc.

730.03 CODES, PERMITS AND INSPECTIONS. All materials furnished and all work performed shall be in accordance with the latest revisions of the National Electrical Code, the National Electrical Safety Code, the requirements of the local power and telephone companies, and the codes, regulations, and rules prevailing in the area in which the work is being performed, insofar as they apply.

730.04 DRAWINGS, BROCHURES AND DESCRIPTIVE DATA. The contractor shall furnish detail drawings, brochures and other descriptive

data for the work in accordance with Subsection 801.03.

730.05 MATERIALS. Materials shall conform to Part X, project specifications, plans and the following general requirements. All materials shall be of the best quality and workmanship and shall be new and of the most advanced proven design available. Throughout the project all units of any one item shall be made by the same manufacturer, but not all the items are required to be made by the same manufacturer. The above items are lighting standards, luminaires, lamps, transformers, controllers, photoelectric relays, ballasts, circuit breakers, transformer bases, panel boards, switches and starters.

Reference to any name, make or manufacturer's number for an article or material or equipment is intended to be descriptive, but not restrictive, and is intended to indicate the quality of materials that will be acceptable.

The contractor may propose the use of other manufacturer's materials on a basis of equality for the purpose intended. Substitutes which may be offered will be subject in every respect to the requirements set forth, and the contractor shall submit detailed specifications and descriptions of such materials, which will be subject to approval by the engineer.

730.06 GUARANTY. The contractor guarantees, by his signing of the contract, all electrical equipment, apparatus, materials and workmanship for a period of one year after the date of final acceptance of the project.

All instruction sheets that are required to be furnished by the manufacturer for materials and supplies and for operation shall be delivered by the contractor to the engineer prior to final acceptance of the project, along with the following warranties and guarantees:

1. The manufacturer's standard written warranty for each piece of electrical equipment or apparatus furnished under this contract.

2. The contractor's written guarantee that, for a period of one year after the date of final acceptance of the project, all necessary repairs to or replacement of said warranted electrical equipment or apparatus will be made by the contractor at no cost to the Department.

3. The contractor's written guarantee for satisfactory operation of all electrical systems furnished and constructed under this contract for a period of one year after final acceptance of the project.

730.07 GENERAL CONSTRUCTION REQUIREMENTS. The contractor shall remove any excess material from excavation, reshape and resod or otherwise repair to the satisfaction of the engineer any portion of the right-of-way or construction area which may have been disturbed and leave the project in a satisfactory condition.

730.08 POWER SUPPLY. The contractor shall make all arrangements with the utility company, and shall furnish and install the service pole

and/or service riser and all the equipment, apparatus, conduit, wire, hardware and incidentals necessary to bring in the service either overhead or underground as shown on the plans. Unless otherwise shown, the service shall be 480 volt, 3 wire, single phase 60 Hertz, AC grounded for lighting systems, and 120/240 volt, 3 wire, single phase, 60 Hertz, AC for buildings. Metering shall be provided as required by the utility company.

Unless otherwise provided, no direct payment will be made for power used for any reason prior to final inspection. The cost of power used during construction and final testing shall be paid by the contractor and shall be included in the price bid on pay items.

730.09 GROUNDING. The entire system shall be grounded and bonded in accordance with the NEC. All equipment shall be grounded. All ground wire for service poles shall be a minimum AWG No. 6, bare, solid, soft drawn copper, attached to a ⅝ inch nominal (½ inch minimum) diameter copperweld steel 10-foot long ground rod with a bronze clamp.

730.10 WIRING. Unless otherwise provided, all conductors shall be stranded copper, per IPCEA specifications. Conductors smaller than AWG No. 12 shall not be used. Conductors shall conform to Subsection 1017.10.

Splices in copper conductors at light standards shall be made up by use of Y or straight splice with fused or unfused disconnect tap, as required, and shall be made with approved, field applied, waterproof connector kits.

Connector kits not requiring a light tap shall be unfused.

Connector kits at the last standard of a circuit or run, or remote ballast shall be of the straight type with fuse.

Connector kits for double luminaire standards shall consist of unfused Y connectors in the feeders and fused straight connectors in the taps.

Splices for pole type ballasts shall be made with pressure type connectors and approved insulating caps.

All other conductor connections in the electrical system shall be made on high pressure, box lug, barrier type terminals. Splices other than those specified above will not be permitted.

730.11 CONDUIT. All conduit above ground or exposed on structures shall be rigid aluminum conforming to Subsection 1017.09. Fittings and covers shall be cast aluminum and covers shall be sealed with neoprene gaskets. Hardware shall be stainless steel.

Underground conduit shall be galvanized rigid steel conforming to Subsection 1017.09, or PVC plastic pipe conforming to ASTM Designation: D 1785.

All conduit for buildings shall be galvanized rigid steel, or rigid aluminum, or galvanized or aluminum electrical metallic tubing. Electrical metal-

lic tubing shall not be placed in the slab, underground, in moist areas or other hazardous locations.

Fittings and covers for steel conduit shall be cast or malleable iron with neoprene gaskets.

All conduits entering disconnects, starters and panel boards shall have union hubs or bolt-on hubs. All conduits entering standards, equipment, etc., shall have insulated grounding bushings, except where bolted hubs are used. All bushings shall be installed prior to pulling wire. Each circuit shall be run into the controller in a separate conduit.

Conduit on the structures shall be surface mounted, strapped at intervals not greater than 5 feet with galvanized malleable iron clamps, clamp backs and nest backs, so that the minimum clearance between the conduit and the structures will not be less than ½ inch. Each conduit run on the structures, from roadway to bent cap for under structure lights, for under structure crossings, and for under structure runs shall contain a short length of liquid-tight flexible metal conduit with bonding strap for expansion deflection.

Conduit on the service poles shall be clamped at approximately 5 foot intervals with heavy duty galvanized 2-hole pipe clamps and stainless steel lag bolts with flat washers, except when channels or "z" bars are used for mounting.

Cut threads on steel conduit shall be given an approved protective coating before assembly and joints shall be made up tight. Aluminum conduit joints shall be treated with an oxide inhibiting compound before assembly and made up tight.

Expansion joints with bonding straps and clamps shall be used wherever conduit runs across expansion joints in the bridge structure.

The maximum length of conduit run between pull points shall not exceed 100 feet. One-eighth inch diameter drain holes shall be drilled at all low points of all surface conduit runs, including expansion joints, before pulling conductors.

730.12 HARDWARE. Unless otherwise specified, hardware shall be as follows:

All hardware used on structures shall be stainless steel. Hardware used for electrical systems in buildings shall be galvanized steel. All bolts shall be hex headed with hex nuts, and shall be fitted with a flat washer and an external tooth lockwasher.

(a) Stainless steel hardware shall be Type 18-8 or approved equal.

(b) Galvanized steel hardware shall be galvanized in accordance with ASTM Designation: A 153. Galvanized bolts shall be in accordance with ASTM Designation: A 307.

730.13 JACKING OR BORING CONDUIT. All conduit required

under roadways shall be rigid steel or Schedule 80 PVC plastic pipe, 2 inch diameter minimum size, installed by jacking or boring. The method of jacking or boring shall not employ the use of water and shall be approved by the engineer prior to beginning the installation. A separate conduit shall be installed for each circuit.

730.14 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. The method of measurement and basis of payment for the electrical systems will be made in accordance with the project specifications, and payment will include furnishing all hardware, fittings and incidental parts that are obviously necessary for a complete installation.

Section 731

Raised Pavement Markers

731.01 DESCRIPTION. This work consists of furnishing and placing reflectorized and nonreflectorized raised pavement markers at the locations shown on the plans or as directed, and in conformance with the plan details and these specifications.

731.02 MATERIALS.

(a) Markers: Markers shall conform to Subsection 1015.09. The same product shall be used throughout the project. Any changes in design or materials of a previously approved product will require requalification by the Department prior to use. Markers shall be reflectorized or nonreflectorized, as specified, and shall be of the class, type, color, size and shape required by the plans or project specifications.

(b) Adhesive: The adhesive used for placing raised markers on the roadway surface shall be a two-component epoxy adhesive conforming to Subsection 1015.09. The two components shall be mixed in equal parts by volume. Mixing and dispensing of adhesive shall be done by mechanical methods, unless hand methods are permitted by the engineer.

731.03 CONSTRUCTION REQUIREMENTS.

(a) Weather Limitations: Application of markers will not be permitted when there is moisture on the pavement surface. If a normal set type of adhesive is used, application of markers will not be permitted at ambient air temperatures less than 50°F. If a rapid set type of adhesive is used, application of markers will be permitted at ambient air temperatures between 35°F and 50°F, provided the adhesive is adequately heated to obtain proper viscosity for mixing and application, and provided the adhesive is identified as a rapid set type on the container labels and the certificates of delivery.

(b) Cleaning of Pavement Surfaces: Pavement surfaces on which markers are to be applied shall be cleaned of all dirt, grease, oil, striping, curing compound, loose or unsound layers, and any other material that would reduce the bond of the adhesive. The surfaces shall be cleaned by blast cleaning or other approved methods; however, when blast cleaning methods are used on asphaltic surfaces, the blast cleaning equipment must

be provided with positive cutoff controls and the cleaning operations shall be performed by approved methods that satisfactorily clean the surface without damaging the pavement. Pavement surfaces shall be maintained in a clean condition until placement of the markers.

(c) **Application of Markers:** Pavement surfaces shall be blown dry immediately prior to marker placement. Markers shall be applied to the pavement surfaces with adhesive in accordance with the manufacturer's recommendations. The adhesive bed area shall be equal to the bottom area of the marker, and adhesive shall be applied in sufficient quantity to cause excess to be forced out around the entire perimeter of the marker. Voids in markers with an open grid pattern on bottom shall be filled with adhesive during placement.

The mixed adhesive shall have a uniformly grey color with no visible evidence of streaks of either black or white on the surface or within the mixed adhesive. Voids in a cured undisturbed sample approximately 1/16 inch thick from the extrusion nozzle shall not exceed 4 percent by volume. Machine mixer and applicator must be capable of accurately and uniformly proportioning the two components in a ratio of 1 to 1 within ± 5 percent by volume of each component (i.e. within range of 47.5 to 52.5 percent for each compound). Periodic checks of the proportioning equipment shall be made to determine the actual ratio of components. This shall be done by containers placed before the mixing chamber and the actual volume of each component measured. The equipment shall be arranged so it is possible to bypass the mixer in order to perform these periodic checks. The temperature of the adhesive shall be maintained at 70°F to 110°F before mixing, with this premix temperature adjusted such that there shall be no excessive flow of epoxy from the marker when installed.

731.04 METHOD OF MEASUREMENT. Raised pavement markers will be measured by counting the number of markers furnished, placed and accepted.

731.05 BASIS OF PAYMENT. The accepted quantity of raised pavement markers will be paid for at the contract unit prices per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
731(1)	Nonreflectorized Raised Pavement Markers (Class)	Each
731(2)	Reflectorized Raised Pavement Markers (Class)	Each

Section 732

Thermoplastic Pavement Markings

732.01 DESCRIPTION. This work consists of furnishing and placing hot extruded reflective thermoplastic pavement markings at the locations shown on the plans or as directed, and in conformance with the Louisiana MUTCD, the plan details and these specifications.

732.02 MATERIALS. The marking material shall be a plastic compound reflectorized by internal and external application of glass spheres, all conforming to Subsection 1015.10. The width and color or markings shall be as required by the plans or project specifications.

The plastic material shall be delivered in containers of sufficient strength to permit normal handling during shipment and transportation without loss of material. Each container shall be clearly marked to indicate color of material, process batch number, name of manufacturer, and date of manufacture. Glass spheres used in drop-on application to the molten stripe shall be shipped in bags of multi-ply paper or burlap with a polyethylene liner, strong enough to permit multiple handling without damage, and having a capacity of 50 pounds of spheres. The bags shall be sufficiently water resistant so that the spheres will not become wet or caked in transit.

732.03 CONSTRUCTION REQUIREMENTS.

(a) Equipment: The material shall be applied to the pavement by extrusion method only, wherein one side of the extrusion shaping die is the pavement and the other sides are formed by suitable equipment for heating and controlling the flow of the material. The equipment shall provide continuous mixing and agitation of material. Conveying parts of the equipment between the main material reservoir and the discharge mechanism shall prevent accumulation and clogging. All parts of the equipment which come in contact with the material shall be easily accessible for cleaning and maintaining. Mixing and conveying parts shall maintain the material at the plastic temperature. The equipment shall assure continuous uniformity in the dimensions of the stripe. The lateral cross section thickness of the material on the pavement shall be no less than 0.090 inch for lane lines, and no less than 0.125 inch for cross lines and symbols. The extrusion applicator shall produce clearly and sharply defined lines and provide means for cleanly cutting off square stripe ends and shall provide a method

of applying skip lines. The use of pans, aprons or similar appliance will not be permitted. The equipment shall produce varying widths of traffic markings. Glass spheres shall be applied to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine in such manner that the beads are dispensed almost instantaneously at controlled rate of flow on the installed line. The glass sphere dispenser shall be equipped with an automatic cutoff control synchronized with the cutoff of the thermoplastic material. Special kettles to hold a minimum of 1,000 pounds of material shall be provided for melting and heating the thermoplastic material. The kettle must be equipped with automatic thermoplastic control devices so that heating can be done by controlled heat transfer liquid rather than direct flame, to provide positive temperature control and prevent overheating of the material. The applicator and kettle must be so equipped and arranged as to satisfy the requirements of the National Board of Fire Underwriters. Applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The applicator equipment to be used on lengthy main roadway installations shall consist of a motorized mobile unit capable of installing traffic stripes, applying the stripe either to the left or right of the applicating unit so that only one lane of traffic will be occupied during installation.

(b) Weather Limitations: Application of thermoplastic markings will not be permitted when the ambient air temperature is below 32°F or when there is moisture on the pavement surface.

(c) Cleaning of Pavement Surfaces: Pavement surfaces on which markings are to be applied shall be cleaned of all dirt, grease, oil, striping, curing compound, loose or unsound layers, and any other material that would reduce the adhesion of the plastic marking compound to the pavement. Cleaning shall be done by approved methods, and the cleaned surfaces shall be maintained in a clean condition until placement of markings.

(d) Application of Markings: The material shall be installed in variable specified widths from 2 inches to 18 inches. Finish lines shall have well defined edges and be free of waviness. On certain pavement surfaces, if recommended by the material manufacturer, a binder-sealer material shall be applied to the road surface prior to the actual thermoplastic installation. The binder-sealer material will form, when sprayed, a continuous film over the pavement surface. To insure optimum adhesion, the thermoplastic material shall be installed in a melted state at a temperature of 400° to 450°F.

Measurements shall be taken as an average throughout any 36-inch section of the line. The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall bond itself to the old line

in such manner that no splitting or separation takes place. Longitudinal lines shall be offset at least 2 inches from construction joints of portland cement concrete pavements.

732.04 METHOD OF MEASUREMENT. Thermoplastic pavement striping of the various widths will be measured by the linear foot of striping placed and accepted. Thermosplastic pavement legends and symbols placed and accepted will be measured per each legend or symbol.

732.05 BASIS OF PAYMENT. The accepted quantities of thermoplastic pavement markings will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
732(1)	Thermoplastic Pavement Striping (____'' Width)	Linear Foot
732(2)	Thermoplastic Pavement Legends and Symbols	Each

Section 733

Median Roadway Barriers

733.01 DESCRIPTION. This work consists of furnishing and constructing concrete median barriers for roadways at the locations shown on the plans and in reasonably close conformity with the plan details and these specifications. Barriers may be precast, slip-formed or cast-in-place concrete, at the contractor's option.

733.02 MATERIALS.

(a) Concrete: Concrete for barriers shall conform to Section 902. Concrete for slip-formed and cast-in-place barriers shall be Class A. Concrete for precast barriers shall be either Class A or P, except that the compressive strength requirements for Class P concrete shall be the same as specified for Class A concrete.

(b) Reinforcement: Steel reinforcing shall be deformed bars conforming to Section 1009.

733.03 CONSTRUCTION REQUIREMENTS. The barriers shall be constructed in accordance with Sections 805 and 806 as modified herein. Exposed surfaces of the barriers shall be given a Class 2 or 2A finish.

The contractor shall perform all necessary excavation and backfilling for the barriers and shall satisfactorily dispose of all excess excavated material.

Slip-formed concrete shall be placed with an approved slip-form placing machine designed to spread, vibrate, consolidate and finish the concrete in one pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense, homogeneous unit. The sliding forms shall be rigidly held together to prevent spreading of forms, and after passing there shall be no noticeable slumping of concrete. The concrete shall be held at a uniform consistency, having a slump of ½'' to 1½'' unless otherwise approved by the engineer. Air entrainment admixture in accordance with Subsection 901.07(b) will be required in concrete used for slip-forming.

Expansion joints shall be formed in accordance with plan details and shall be located at the junction of the barrier with bridge railings, footings for sign supports and lighting standards, and other fixed structures. Vertical dummy joints shall be formed at intervals not exceeding 20 feet. All vertical joints in the barriers shall match the joints in existing underlying concrete pavement,

unless otherwise directed, with intermediate joints placed as required not to exceed the 20-foot maximum spacing. The dummy joints shall be formed to a minimum depth of 1½ inches by means of an approved jointing tool or by sawing the plastic concrete.

733.04 METHOD OF MEASUREMENT. The quantities of concrete barriers for payment will be the design lengths as specified on the plans and adjustments thereto. Design lengths will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

Design quantities are based on the lengths of continuous sections of barrier, including joints but excluding other openings in the barrier. Unless otherwise provided, all required excavation, backfill, disposal of excess excavated material, reinforcement, joint materials and admixtures will be considered incidental to the work and will not be measured for separate payment.

733.05 BASIS OF PAYMENT. The accepted quantities of concrete barriers for roadways will be paid for at the contract unit price per linear foot.

Payment will be made under:

Item No.	Pay Item	Pay Unit
733(1)	Median Roadway Barrier (Type)	Linear Foot

Section 734

Breaking and Seating Pavement

734.01 DESCRIPTION. This work consists of rolling, breaking and seating existing pavements at the locations indicated on the plans or as directed, in accordance with these specifications.

734.02 EQUIPMENT. All equipment necessary for satisfactorily breaking and seating the existing pavements shall be furnished and maintained by the contractor and shall include the following.

(a) Roller: The roller shall be a 50-ton pneumatic-tire roller consisting of 4 rubber tired wheels equally spaced across the full width and mounted in line on a rigid steel frame in such manner that all wheels carry equal loads, regardless of surface irregularities. The roller tires shall be capable of satisfactory operation at a minimum inflation pressure of 100 psi, and tires shall be inflated to the pressure necessary to obtain the proper surface contact pressure to satisfactorily seat the pavement slabs. At the contractor's option, tires may contain liquid. The roller shall have a weight body suitable for ballasting to a gross load of 50 tons, and ballast shall be such that the gross roller weight can be readily determined and so controlled as to maintain a gross roller weight of 50 tons. The roller shall be towed with a rubber tired prime mover capable of maintaining speeds of 2 mph and capable of turning 180 degrees within a 30-foot width.

(b) Impact Hammer: The impact hammer shall have a minimum striking area of one square foot and shall be capable of developing sufficient energy to satisfactorily break the pavement slabs without excessive shattering or punching.

734.03 CONSTRUCTION REQUIREMENTS. The sequence of operations shall be as directed by the engineer and shall generally be as follows. Locate moving pavement slabs with one coverage of the roller; break the moving slabs with the impact hammer; apply a seating coverage with the roller, also locating additional or continuing rocking slabs with this coverage; accomplish additional breaking required with the impact hammer; and final seating coverage of the roller. No less than 2 nor more than 3 coverages of the roller shall be used.

Slab breaking and seating shall be accomplished prior to the placement of any required widening course. Breaking and seating of pavements shall not

be accomplished until trenches are cut on both sides of the existing slab to a depth of the thickness of existing pavement. Trenches shall be backfilled immediately after breaking and seating operations.

Unless otherwise directed by the engineer, after completion of breaking and seating operations, the contractor shall place asphaltic tack coat and a minimum of 1 inch thick asphaltic concrete leveling course. Leveling course shall consist of either binder or wearing course, at the contractor's option. Pavement areas that have been broken and seated shall not be left unsurfaced longer than 24 hours. Asphaltic concrete leveling course will be measured and paid for under appropriate pay items. Unless otherwise provided, asphaltic tack coat will be considered as incidental to the work and will not be measured for separate payment.

During operation of the roller, care must be taken to insure that no bridges or cross drains are displaced, overloaded, or otherwise disturbed due to the high intensity of the loaded roller. The loaded roller shall not be operated outside of project construction limits.

There shall be no application of the roller for proof rolling purposes after application of the leveling course.

734.04 METHOD OF MEASUREMENT.

(a) Rolling and Seating: Rolling and seating pavement will be measured by the square yard of area rolled and accepted, regardless of whether the area has received 2 or 3 coverages. The width for measurement will be as shown on the plans, and the length will be the actual centerline length measured along the riding surface.

(b) Breaking: Breaking of pavement will be measured by the hour, which includes the time required for moving the crew from location to location during these operations. If more than one crew is employed in breaking pavement, the time of each crew will be measured. Idle time or time used in moving tools and equipment on or off the job will not be measured.

734.05 BASIS OF PAYMENT. Rolling and seating of pavement will be paid for at the contract unit price per square yard, and breaking of pavement will be paid for at the contract unit price per hour.

Payment will be made under:

Item No.	Pay Item	Pay Unit
734(1)	Rolling and Seating Pavement	Square Yard
734(2)	Breaking Pavement	Hour

Section 735

Undersealing Pavement

735.01 DESCRIPTION. This work consists of undersealing existing pavements by drilling holes and pumping a portland cement slurry under pavement slabs to fill cavities, seal the underside of slabs and, when required, correct vertical alignment of pavements, all in accordance with the plans, these specifications and as directed.

735.02 MATERIALS. Materials for undersealing shall conform to the following requirements.

(a) Portland Cement: Cement shall be high early strength portland cement (Type III) conforming to Section 1001.

(b) Water: Water shall conform to Subsection 1017.01.

(c) Calcium Chloride: Calcium chloride shall be Type 2 conforming to Subsection 1017.02.

(d) Soil: Soil shall be Class A-4 conforming to DOTD Designation: TR 423; shall be free of large clay lumps, rocks, sticks, roots, trash or other debris; shall be reasonably free of grass roots and small clay lumps; and shall contain not more than 5 percent organic material.

735.03 EQUIPMENT. All equipment necessary to satisfactorily underseal the pavements shall be furnished and maintained by the contractor, and shall include the following.

(a) Air Compressors and Drills: Air compressors shall be equipped with air-lift pneumatic drills capable of drilling 2 holes simultaneously through the pavement.

(b) Mixer: The mixer shall be capable of thoroughly mixing the grout ingredients and accurately adding the required amounts of water.

(c) Pump: The pump shall be a positive action type capable of forcing the cement slurry through the drilled hole in the pavement and into the cavities below the pavement. The pump shall be capable of supplying pressures varying from 1 to 50 psi at the end of the discharge pipe.

(d) Roller: The roller shall be a pneumatic-tire roller with a minimum weight of 9 tons and not exceeding 35 tons gross weight.

735.04 PROPORTIONING. The slurry shall consist of 1 part portland cement and 3 parts soil, by volume. Calcium chloride shall be added at a maximum rate of 2 percent by weight of cement; however, the use of calcium chloride shall be discontinued if, in the engineer's opinion, the slurry is setting too rapidly for satisfactory placement. Water shall be added in amounts as directed by the engineer to produce a slurry consistency that can be satisfactorily pumped into the cavities under the slabs without stooling.

735.05 CONSTRUCTION REQUIREMENTS. Holes of 1½-inch diameter or other approved size shall be drilled through the pavement at locations specified on the plans or as directed. Drills shall be rotated to avoid cracking the pavement and shall be held as nearly perpendicular as possible to the pavement surfaces. Holes which cannot be satisfactorily used in pressure grouting shall be filled with grout and new holes drilled. No more holes shall be drilled than can be grouted during a day's operations unless otherwise directed.

After holes are drilled, a pipe connected to the discharge hose on the pressure grout pump shall be lowered into the hole. The discharge end of the pipe shall not extend below the lower surface of the concrete pavement.

Pumping of grout into a hole shall continue until the slab begins to rise, and if a grade raise in the slab is desirable, the pumping of the grout in the hole shall continue until the desired grade raise in the slab has been attained. In most cases pumping will be required in several holes across the full width of the slab to accomplish a desired raise in the grade. Normally, the raising of the slab or the flowing of grout out of an adjacent hole during grouting is sufficient evidence that all cavities or voids are filled within range of the hole being grouted.

If stooling of grout occurs, additional holes shall be provided in the slab as directed and a more fluid grout shall be pumped through these new holes to fill the voids between the stools.

If back pressure forces grout out of the hole onto the slab after withdrawal of the discharge pipe, the hole shall be temporarily plugged with a wood plug until the grout has set. After completion of grouting in a hole, the discharge pipe or wood plug shall be removed and the hole filled with grout.

Grouting in an area shall be continued until, in the opinion of the engineer, all cavities beneath the pavement in that area have been filled. After at least 2 hours have elapsed after completion of pressure grouting an area, the contractor shall proof roll the area with 1 to 3 passes of the pneumatic-tire roller. If slab movement is detected during the rolling, the area shall be regrouted. The grouting and proof rolling process shall be continued until no slab movement is detected during the proof rolling.

The construction methods outlined herein may be modified by the engineer as field conditions indicate.

735.06 METHOD OF MEASUREMENT. Undersealing pavement, completed and accepted will be measured per hundred pounds (CWT) of portland cement used in the undersealing slurry. Holes for undersealing will be measured per each hole acceptably drilled. Soil, calcium chloride and water will be considered incidental to the work and will not be measured for separate payment.

735.07 BASIS OF PAYMENT. The accepted quantities of undersealing pavement and holes for undersealing will be paid for at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
735(1)	Undersealing Pavement	CWT
735(2)	Holes for Underseal	Each

PART VIII

STRUCTURES

Section 801

General Requirements for Structures

801.01 DESCRIPTION. This section sets forth general requirements for the construction of bridges and other structures and includes preparation and submittal of shop drawings and other data. All bridges and other structures shall be constructed in reasonably close conformity with the lines, grades, dimensions and designs shown on the plans and in accordance with the project specifications.

In addition, all work within wetlands, navigable waters or adjacent areas shall conform to the requirements of Subsection 107.09.

801.02 BORINGS. Soil borings and other subsoil investigations and soil analyses will be made by the Department for development of subsurface information for bridge foundations. This data will be included in the plans for informational purposes. Soil samples may not be available for inspection and bidders should make such additional investigations as they consider necessary to determine the subsoil conditions. No additional compensation, other than contract prices on pay items, will be allowed the contractor should it develop during construction of a project that the subsoil material is of a different character from that shown on the plans.

801.03 SHOP DRAWINGS AND WORKING DRAWINGS. The contractor shall be required to submit shop drawings, working drawings and other submittals for approval as hereinafter described. Except as otherwise provided, no work shall be started until final approval of the shop and working drawings has been obtained. No additional payment will be made for shop and working drawings and other submittals required in this subsection as the cost shall be considered as included in the prices bid for the various contract items.

(a) General: Two prints of required shop or working drawings shall be submitted to the Department's Bridge Design Engineer for checking, one of which will be returned with either approval or required revisions noted thereon. For final approval and distribution, 9 prints of each checked drawing shall be submitted to the Bridge Design Engineer. Upon completion of fabrication or erection, one set of prints of the final, corrected shop and working drawings, suitable for microfilming shall be delivered to the Bridge Design Engineer. Changes made on drawings shall be noted

and dated to show that a revision is made. Unless otherwise specified, all tracings and subsequent reproductions shall be 22 inches by 36 inches overall with ½ inch margins at top, right and bottom edges and a margin of not less than 1½ inches at the left edge. No trim lines are necessary. Each sheet shall have a title block in the lower right hand corner with the state project number, project name, parish, fabricator's and contractor's name, fabricator's plant location, sheet number, date and revision block.

(b) Procedures when Shop Drawings and Working Drawings will be Checked and Handled by Consulting Engineers: When specified in the project specifications, the contractor shall furnish the consulting engineers shop and working drawings for checking, approval and distribution.

Two prints of required shop or working drawings shall be submitted for checking to the consulting engineers whose address is listed in the project specifications. After all corrections required by the consulting engineers are made, 9 prints of each checked drawing shall be submitted to the consulting engineers for final approval. Final checked prints shall be stamped "Approved" and dated by the consulting engineers; 1 print of each shall be retained by the consulting engineers; the remaining 8 prints of each drawing shall be sent to the Bridge Design Engineer for distribution.

Upon completion of fabrication or erection, one set of prints of the final, corrected shop and working drawings shall be delivered to the consulting engineers for transmittal to the Department.

During the process of approval, a copy of each transmittal letter from contractor to the consulting engineers shall be sent to the Department's Bridge Design Engineer and the consulting engineers shall in turn send a copy of each letter of reply.

All other applicable requirements of this subsection shall apply.

(c) Falsework: The contractor shall prepare and submit to the engineer, for review, plans proposed to be used for construction of all items of work requiring temporary supports usually classified as falsework. This requirement shall also apply to falsework required for changes in an existing structure necessary for maintenance of traffic. The term "falsework" shall be defined to mean a temporary construction work on which a main work is wholly or partly built and supported until it is strong enough to support itself; a temporary framework used to support a part or all of a structure during demolition.

Review of falsework drawings shall in no way relieve the contractor of his responsibility under the contract.

(d) Form Drawings: When requested by the engineer, the contractor shall prepare and submit to the engineer for review, plans for his proposed forming system for all cast-in-place concrete. The plans shall be sufficiently detailed to allow a complete evaluation of their suitability and

adequacy. In the case of deck forms, the plans should include details of the type screed to be used.

Review of these drawings shall in no way relieve the contractor of his responsibility under the contract.

(e) **Steel Fabrication and Erection:** Detail drawings shall be furnished by the contractor for approval. The type, size and procedures for submittal and approval of these drawings shall be as described and required under headings (a) and (b) of this subsection.

(1) **Shop Drawings:** The contractor shall furnish shop drawings for all steel work for approval and no fabrication shall be started prior to final approval of these plans; provided, however, that when the project has separate complete structures or has been divided into parts to facilitate construction in accordance with the approved construction schedule, fabrication may be started for a complete structure or a particular part when the final shop details applying thereto have been approved and distributed. These details must conform to the general drawings, stress sheets and specifications, and no deviations from the approved shop plans will be allowed without written consent of the engineer. The contractor shall be responsible for the correctness of the drawings and for shop fits and field connections, even though the drawings have been approved.

If the structural steel on the project consists only of expansion dams and bearing assemblies, the contractor will not be required to furnish a final set of corrected drawings.

(2) **Erection Drawings:** Before starting the work of steel erection, the contractor shall inform the engineer fully as to the method of erection he proposes to follow and the amount and character of the equipment he proposes to use, which shall be subject to review. He shall prepare and submit for review a key erection diagram and detail erection drawings for the work, all with dimensions and erection marks as appropriate to properly coordinate the erection drawings with the shop drawings for the work.

In addition to the above, the contractor shall submit erection drawings for all continuous span steel units, trusses and other metal work requiring field splices, to the Bridge Design Engineer for review. The drawings shall fully outline the erection procedure and the amount and character of the equipment to be used.

Approval of the methods, procedures and erection drawings shall in no way relieve the contractor of his responsibility under the contract.

(3) **Shipping Statements and Shop Bills:** The contractor shall furnish the engineer one copy of shipping statements, or notices, as each shipment of structural steel is made to the project. The weights of individual members shall be shown on the shipping statements.

If the payment for structural steel is per pound, the contractor shall also, at the appropriate time during construction, furnish the Bridge Design Engineer with 3 copies of the final shop bills for the structural steel item, which bills shall show the name, piece-mark, and calculated weight for each member. These bills shall include a summary of the weights of structural steel for the project by grades. Shop bills are not required when lump sum payment is to be made.

(f) Movable Bridge Equipment: Detail drawings shall be furnished by the contractor for approval as follows:

(1) Shop Drawings and Erection Drawings: The contractor shall furnish a complete conduit and wire layout, elementary wiring diagram, detailed working drawings of the switchboard, control desk, junction boxes, machinery houses, operating house, counterweights, including calculations, and machinery and traffic barrier parts and assembly lay-outs of all items he is to furnish. Weights of machinery parts shall be shown on shop drawings and may be estimated initially; however, the final shop drawings shall show the correct weights as determined by weighing the fabricated parts. For commercial parts, the manufacturer's weights from certified dimension sheets will be acceptable. Certified dimension sheets of motors, brakes, generators, gasoline engines, limit switches, traffic gates and all other such equipment shall be submitted to the Bridge Design Engineer for approval as soon as practicable after the award of the contract so that the engineer and the fabricator will have the information necessary to determine the details of associated parts. Certified dimension sheets shall show complete specifications for the equipment furnished.

All equipment and apparatus shall be as shown on the plans, or the approved equal. The contractor shall submit 9 copies of certified dimension sheets and detailed manufacturer's description of each piece of equipment and apparatus to the Bridge Design Engineer, one of which will be returned approved or with the required revisions noted thereon. If any revisions are required on the original submittal, the contractor shall submit 9 corrected copies for final approval. The name of the project, project number and parish in which the project is located shall be shown on each sheet of every submittal, with some indication of what was actually changed on the drawings.

Except as otherwise provided, the contractor will not be required to submit single conductor wire, but all multiple conductor cables shall be submitted for review.

The description for cables shall include a construction layout sketch, the size and number of conductors, the type and thickness of sheath, the type and size of armor, the type and thickness of jacket, the diameter of the core, the diameter under jute bedding and the overall diameter of the cable. The above descriptions shall be shown on the shipping tags of the

various wires and cables delivered to the bridge site. If the information on the shipping tags does not conform to the description approved by the Bridge Design Engineer or if there is reason to believe that the construction and materials of the wires and cables do not conform to the approved descriptions, the engineer reserves the right to obtain samples of the wires and cables delivered to the bridge site and have these samples tested.

The conduit and wire layout shall show the size and approximate length of all conduits, and the number, size, type and identification of all conductors in each conduit run. Identification of the conductors shall be with the same symbols used in the elementary wiring diagram.

The drawings for the control desk and switchboard shall be complete and shall include cabinet dimensions, layout of equipment, nomenclature of equipment, the rating, description, catalog number and name of manufacturer of all equipment and complete wiring diagrams. The sizes of all conductors larger than No. 12 AWG shall be shown on all drawings, and each conductor and piece of equipment shall be identified with the same symbol wherever shown.

The drawings for the counterweights shall show all dimensions, method of construction and all necessary calculations.

A detailed list of all electrical equipment and devices, all commercial machinery and traffic barrier parts installed on the bridge shall be included in the shop drawings. The list shall be complete and shall include an item number that is the same as that shown on all drawings and the name, ratings, description, service manufacturer, type, model, catalog and serial number of each item.

The type, size and procedures for submittal and approval of shop drawings and erection drawings and delivery of final, corrected shop and working drawings shall be the same as described and required under headings (a) and (b) of this subsection.

If any part of the work, not requiring fabrication, is so completely detailed that the design drawings may serve as working drawings, the contractor will not be required to submit shop drawings for that part of the work, provided that he notifies the Bridge Design Engineer, in writing, that the work is to be performed exactly as shown on the design drawings, but the contractor shall be responsible for any errors which may be on the plans, and will not be relieved of any responsibility placed upon him by his contract. However, shop drawings will be required for all fabricated items.

(2) **Maintenance and Operation Instruction Booklets:** The contractor shall furnish 6 bound copies of a booklet, 8½ inches by 11 inches in size, containing descriptive leaflets and drawings covering all items of the electrical equipment, with catalog numbers indicated, printed or

typewritten statements prepared by the manufacturers of the equipment covering the proper method of adjusting, lubricating and otherwise maintaining each item, a concise statement of the necessary operating functions in proper sequence, a detailed description of the functions of each item in connection with the various operating steps, reduced copies of all conduit and wiring diagrams and drawings of the control desk and switchboard. The booklet shall contain a table of contents and shall designate each wire and item of equipment by the numbers and symbols used on the drawings.

The contractor shall also furnish 6 bound copies of a similar booklet for the mechanical and traffic barrier equipment which shall include lubricating charts showing the locations of all lubricating fittings and other points of lubrication, as well as the recommended types of lubricant and frequency of application and changing of lubricants.

The booklet shall also include reduced prints of the machinery and traffic barrier shop drawings.

No additional payment will be made for these booklets; the cost thereof shall be considered as included in the prices bid for the various items.

(g) **Precast-Prestressed Concrete Girder Spans:** The contractor shall furnish complete fabrication drawings and erection diagrams, and no girders shall be cast prior to final approval of these plans.

Fabrication drawings shall include complete details and dimensions of the girders, details of the proposed casting bed layout and stressing data and, in pretensioned members, the method of holding draped strands in place, and the method and schedule of release of hold-downs and cable strands.

If the girders are detailed so completely that the design drawings may serve as working drawings, the contractor will not be required to submit drawings for that part of the work, provided he notifies the Bridge Design Engineer in writing that the work is to be done as shown on the design drawings. However, the contractor shall submit corrections to plan dimensions due to elastic shortening, shrinkage, girder slope and other causes, and the use of such design drawings will not relieve him of any responsibility placed on him by his contract.

Erection diagrams will show the location of each girder in each of the prestressed girder spans and shall be coordinated with identifying marks on the girders. Identifying girder marks showing the location and span for which the girder is cast and the date of casting shall be shown on one end of each girder.

The type, size and procedures for submittal and approval of fabrication and erection drawings shall be the same as described and required under headings (a) and (b) of this subsection.

(h) Highway Illumination System: Detail drawings, brochures and descriptive data shall be furnished by the contractor for approval as follows:

(1) Shop and Working Drawings: The contractor shall furnish a lighting standard and conduit layout, detailed working drawings of all standards and brackets, mounting details of service equipment and a complete equipment listing. The lighting standard and/or high mast tower details shall include details of all connections, bases, welds, anchor bolts, handhole reinforcement and erection procedure. The lighting standard and conduit layout shall show the location of each standard or luminaire by station, the circuit number and the number of the service pole. The locations of service poles, all trenches and conduit runs and the sizes and number of cables in each trench or conduit run shall be indicated. The various types and sizes of wires and cables shall be clearly identified on the plans.

At the option of the contractor, the design drawings may serve as working drawings, provided he notifies the Bridge Design Engineer in writing, that the work is to be performed exactly as shown on the design drawings, but the contractor will be held responsible for any errors that may be on the plans, and he will not be relieved of any responsibility placed upon him by his contract. However, shop drawings will be required for all standards, brackets, high mast towers, and all other fabricated items.

The type, size and procedures for submittal and approval of these drawings shall be the same as described and required under headings (a) and (b) of this subsection.

(2) Equipment and Apparatus: The contractor shall submit 6 copies each of required brochures and descriptive data to the Bridge Design Engineer for approval. This information shall include the type of cables and wire and other equipment and apparatus he proposes to furnish in order to establish that such material is the equivalent of that specified. All submittals shall be originals or copies equal to originals. Each copy of every submittal shall be identified with state project number(s), project name, parish(es), contractor and date.

Except as otherwise provided, the contractor will not be required to submit single conductor wire for approval. Multiple conductor cables and cable duct systems shall be submitted. The description shall include manufacturer's name, marking on the insulation, size and stranding of the conductor, thickness and type of insulation, thickness and type of sheath and overall diameter of the cable.

One copy of each original submittal will be returned to the contractor with approval, rejection or required revisions marked thereon. If submittal is marked approved, no additional copies will be necessary. If

submittal was rejected, the contractor shall submit 6 copies of acceptable data for final checking and approval. If original submittal is marked for revisions, 6 copies of the revised submittal shall be returned to the Bridge Design Engineer for final checking and approval.

(i) **Traffic Signs and Devices:** Detail drawings for overhead and structure mounted signs and devices shall be furnished by the contractor for approval. Fabrication or construction shall not be started until drawings have been approved and distributed.

(1) **Fabrication and Erection of Overhead and Structure-Mounted Sign Structures:** The type, size and procedures for submittal and approval of these drawings shall be as described and required under headings (a) and (b) of this subsection.

Detailed drawings for fabrication and erection of aluminum and steel parts for overhead and structure-mounted sign structures shall include details of all parts of the sign structure and mounting brackets.

All backing details to be used that are not specifically covered by the typical details and notes shown on the plans shall be submitted.

(2) **Sign Face Details:** Sign face details shall be submitted to the Department's Interstate Engineer for approval. The details shall be submitted on legal size sheets of acceptable quality for all sign faces not completely detailed and described on the plans.

Two prints of required sign face details shall be submitted for checking, one of which will be returned with either approval or required revisions noted thereon.

Nine copies of prints shall then be submitted and if approved shall be distributed.

Approval and distribution of these prints shall be required prior to submittal of drawing for fabrication and erection of the corresponding sign structures involved.

(j) **Building or Building Complex:** Detail drawings, brochures and samples for architectural, mechanical and electrical work shall be furnished by the contractor for approval by the Bridge Design Engineer in accordance with the project specifications and the following requirements:

The type, size and procedures for submittal and approval of shop and working drawings shall be as described under headings (a) and (b) of this subsection. No fabrication or erection work shall begin until these drawings have been approved by the Bridge Design Engineer. The drawings shall be in accordance with the project specifications. Brochures and samples shall be furnished in accordance with the project specifications.

Maintenance and operation instruction booklets shall be furnished in accordance with the project specifications.

801.04 AIR NAVIGATION. The Department will obtain a permit (or a determination of no hazard to air navigation) from the Federal Aviation Administration for all permanent structures. The contractor will be furnished a copy of the permit, if requested. If the contractor's equipment, falsework, etc. is classified as a hazard to aerial navigation, the contractor shall prepare, on tracing cloth or approved reproducible drawings, drawings complying with the Federal Aviation Administration's current requirements for temporary lighting for the protection of aerial navigation. These drawings shall be submitted to the Bridge Design Engineer for review and transmittal to the Department of Transportation, Federal Aviation Administration, for approval. All operations in connection with the work for protection of aerial navigation shall be in accordance with the approved drawings and applicable Federal regulations. Failure of the contractor to familiarize himself with all applicable rules and regulations of the Federal Aviation Administration will not relieve the contractor of his responsibility under the contract.

801.05 HAZARD ZONES. If any portion of the work is determined to be within a hazard zone because of aerial navigation, a high voltage powerline which is to remain or because of any other permanent facility deemed to constitute a similar hazard in performance of the work, the presence of such hazards will be noted in the plans or project specifications to the extent that definite information can be obtained on these situations.

It shall be the responsibility of the contractor to arrange, with the agency concerned, for any adjustments relative to his work in the area. Any liability or expense of these arrangements shall be borne by the contractor.

The contractor shall obtain and submit to the Department, a release signed by the agency involved stating that the contractor has satisfactorily discharged his obligations under the terms of the arrangements or agreements involved.

All of this shall be noted on the Department's Standard Release form and submitted, with required signatures, to the engineer.

Failure of the Department to determine the presence of any and all hazards and to so note in the plans or project specifications shall not relieve the contractor of performing the work in accordance with the project requirements and at contract unit prices.

Section 802

Structural Excavation and Backfill

802.01 DESCRIPTION. This work consists of the removal of all materials, of whatever nature, necessary for the construction of retaining walls, foundations and substructures. It shall include the furnishing of all necessary equipment and the construction of all cribs, cofferdams, caissons, dewatering, etc. which may be necessary for the execution of the work. It shall also include the subsequent removal of cofferdams and cribs and the placement of all necessary backfill as hereinafter specified. It shall also include the wasting of excavation material, which is not required for backfill in a manner and in locations so as not to affect the carrying capacity of the channel and not be unsightly, all as directed by the engineer. All work shall be performed in accordance with these specifications and in reasonably close conformity to the lines, grades and dimensions shown on the plans or established by the engineer.

802.02 GENERAL CONSTRUCTION REQUIREMENTS. Excavations for substructures shall be shored, braced or protected by cofferdams where necessary. When footings can be placed in the dry without the use of cribs or cofferdams, backforms may be omitted with the approval of the engineer and the entire excavation filled with concrete to the required elevation of the top of the footing. The additional concrete required shall be placed at the expense of the contractor.

802.03 PRESERVATION OF CHANNEL. Unless otherwise specified or permitted, no excavation shall be made outside of caissons, cribs, cofferdams or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed. If any excavation or dredging is made at the site of the structure before caissons, cribs or cofferdams are sunk or in place, the contractor shall, without extra charge, after the foundation base is in place, backfill all such excavation to the original ground surface or river bed with satisfactory material. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction thereby. The contractor's attention is also directed to Subsection 107.09.

802.04 DEPTH OF FOOTINGS. The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only and

the engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

802.05 PREPARATION OF FOUNDATIONS FOR FOOTINGS. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface, either level, stepped or roughened, as directed. All seams shall be cleaned out and filled with concrete, mortar or grout to a suitable depth.

When concrete is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final removal of the foundation material to grade shall not be made until just before the concrete is to be placed.

802.06 COFFERDAMS AND CRIBS.

(a) General: Cofferdams and cribs for foundation construction shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for the proper performance of the work which must be done inside them. In general, the interior dimensions of cofferdams and cribs shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted, reset or enlarged so as to provide the necessary clearance and this shall be at the expense of the contractor.

When conditions are encountered which render it impracticable to dewater the foundation before placing concrete, the engineer may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation shall then be pumped out and the balance of the concrete placed in the dry. When weighted cribs are employed and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorages such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

(b) Protection of Concrete: Cofferdams or cribs shall be constructed so as to protect foundations from damage caused by a sudden rising of the stream eroding green concrete. Timber from cofferdams or cribs cannot be left embedded in substructure concrete.

(c) Drawings Required: Drawings for substructure work shall be furnished in accordance with Subsection 801.03.

(d) Removal: Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed after the completion of the substruc-

ture, care being taken not to disturb or otherwise injure the finished concrete. No sheet piling used as forms shall be removed prior to 7 days after placement of concrete.

802.07 PUMPING. Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of at least 24 hours thereafter unless it be done from a suitable sump separated from the concrete work by a watertight wall or other effective means.

Pumping to dewater a sealed cofferdam shall not begin until 72 hours after placement of concrete seal unless otherwise directed by the engineer.

802.08 INSPECTION. After each excavation is completed, the contractor shall notify the engineer, and no concrete shall be placed until the engineer has approved the depth of the excavation and the character of the foundation material.

802.09 BACKFILL. All material used for backfill shall be of acceptable quality and shall be free from large or frozen lumps, wood, or other extraneous material.

(a) **For backfilling cofferdams and cribs,** all spaces excavated and not occupied by piers or other permanent work shall be refilled with earth up to the surface elevation of the surrounding ground in such manner as to maintain approximately the same elevation on each side so as to avoid unbalanced pressure on the structure.

(b) **Backfilling of Reinforced Concrete Box Culverts:** The material and backfilling requirements for the backfilling of reinforced concrete box culverts and their attached headwalls shall be in accordance with Subsection 701.08.

The contractor shall provide adequate earth cover over reinforced concrete box culverts before heavy construction equipment may cross the installation. The fill shall be approved by the engineer.

(c) **The backfill around structures other than (a) and (b) above** shall be deposited in horizontal layers not to exceed 9 inches in thickness (loose measurement) and compacted to the approximate density of the adjacent natural ground. The backfill in front of such units shall be placed first to prevent any wedging action against the concrete, and the slope bounding the excavation shall be stepped or roughened to prevent wedge action. Jetting of the backfill behind the abutments and wing walls will not be permitted. The excavation will be pumped as dry as practicable before beginning backfilling.

(d) **No backfill shall be placed** against any concrete abutment, wing wall or reinforced concrete box culvert until the concrete has been in place 14 days, or until test cylinders show a compressive strength of 3000 psi as

determined under Subsection 805.11, Method 1.

802.10 METHOD OF MEASUREMENT. The quantity of structural excavation to be paid for shall be the actual number of cubic yards, measured in its original position, of the material acceptably excavated in conformity with the plans or as directed. No yardage shall be included in the measurement for payment which is outside of a volume bounded by vertical planes 18 inches outside of and parallel to the neat lines of the footing. The cross-sectional area measured shall not include water or other liquids but shall include mud, muck and other similar semi-solids. No measurement for payment will be made of excavation required for the construction of abutment bents or abutment footings. Measurements for intermediate bents or pier footings will be made on the basis of the depth taken from the elevation of the completed section or natural ground line, whichever is lower for the pier or bent in question, to the bottom of the footing; however, no payment will be made for material not actually excavated.

When it is necessary to carry the foundations below the elevations shown on the plans, the excavation for the first 2 feet of additional depth shall be included in the quantity for which payment will be made at the contract unit price for this item. Excavation below this additional 2-foot depth will be paid for at a price to be determined by multiplying the contract unit price for the item by the following factors:

For footings or portions thereof lowered more than 2 feet but not more than 4 feet 1.25
For footings or portions thereof lowered more than 4 feet and not more than 6 feet 1.50
For footings or portions thereof lowered more than 6 feet and not more than 8 feet 1.75
For footings or portions thereof lowered more than 8 feet and not more than 10 feet 2.00
For footings lowered more than 10 feet, the quantities below such depth will be paid for as extra work.

Reinforced Concrete Box Culverts: Excavation required for box culvert construction will be considered incidental to the work and will not be measured for direct payment, except as otherwise specified in Subsection 203.19.

When the contract does not contain a pay item for "Conduit Backfill" for reinforced concrete box culverts, the backfill of the box culverts will be considered as incidental to the work and will not be measured for direct payment.

When the contract contains a pay item for "Conduit Backfill" for reinforced concrete box culverts, the backfill for the box culverts and attached headwalls will be measured in accordance with the provisions of Subsection 701.10.

802.11 BASIS OF PAYMENT. The accepted quantities of structural

excavation will be paid for at the contract unit price per cubic yard, which includes constructing and removing cribs and cofferdams, all required excavation and backfill, and disposing of all excess excavated material; except when the contract contains a pay item for "Conduit Backfill" for box culverts, the accepted quantity of backfill will be paid for in accordance with the provisions of Subsection 701.11.

Payment will be made under:

Item No.	Pay Item	Pay Unit
802(1)	Structural Excavation	Cubic Yard
802(2)	Structural Excavation for Intermediate Bents	Cubic Yard
802(3)	Structural Excavation for Piers (Dry)	Cubic Yard
802(4)	Structural Excavation for Piers (Wet)	Cubic Yard

Section 803

Sheet Piles

803.01 DESCRIPTION. This work consists of furnishing and driving sheet piling of the type shown on the plans or in the project specifications and covers only sheet piling designated on the plans, or ordered by the engineer to be left in place to become a part of the finished structure.

Sheet piling shall be one of the following types:

Timber Sheet Piles (Untreated)
Timber Sheet Piles (Treated)
Concrete Sheet Piles (Reinforced)
Concrete Sheet Piles (Prestressed)
Steel Sheet Piles

803.02 TIMBER SHEET PILES.

(a) General: Timber sheet piles shall be untreated unless the plans or project specifications specifically provide for the use of treated timber. The piles shall be of the thickness specified or as directed and shall be provided with tongues and grooves of ample proportions, either cut from the solid material or made by building up the piles with 3 planks securely fastened together. The pile shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together during driving.

Hardware shall conform to Section 812 and shall be galvanized unless otherwise indicated on the plans or in the project specifications.

(b) Untreated Timber Sheet Piles: The timber, unless otherwise definitely noted on the plans or in the project specifications to be in accordance with Section 812, may consist of any species which will satisfactorily stand driving. It shall be sawn or hewn with square corners and shall be free from worm holes, loose knots, wind shakes, decayed or unsound portions and other defects which might impair its strength or tightness.

(c) Treated Timber Sheet Piles: Treated timber shall be either Southern Pine or Douglas Fir conforming to Section 812 treated with creosote oil in accordance with Section 1014.

All cuts in treated timber and all abrasions after having been carefully trimmed shall be covered with 2 applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or brush coated with at least 2 appli-

cations of hot creosote oil and covered with hot roofing pitch.

803.03 CONCRETE SHEET PILES.

(a) **General:** Where conventionally reinforced or prestressed concrete sheet piles are required, they shall be fabricated in accordance with the detailed design. The requirements governing the manufacture and installation of concrete sheet piling shall conform, in general, to those governing precast-prestressed concrete bearing piles in Sections 804 and 805.

(b) **Concrete:** Concrete shall conform to Sections 805 and 901.

(c) **Reinforcing Steel:** Reinforcing steel shall conform to Section 806.

803.04 STEEL SHEET PILES. Steel sheet piles shall be of the specified type and weight conforming to Subsection 1013.10. All piling shall conform in other respects (tests, specimens, number of tests, finish, marking and inspection) to Section 807.

803.05 DRIVING SHEET PILES. Sheet piles shall be driven with adequate hammers as necessary to drive the piles to the required depth in satisfactory condition.

In order to maintain satisfactory alignment, the sheet piles shall be driven in such increments of penetration as may be found necessary to prevent distortion, twisting out of position or pulling apart at the interlocks. To facilitate closure, it may be advantageous to set up the piles for a complete length of wall before initial driving; the piles thus set up, then can be progressively driven in short increments of penetration.

803.06 JETTING SHEET PILES.

(a) The use of jets will not be permitted at locations where the stability of embankments or other improvements would be endangered.

(b) The contractor may supply and operate one or more high pressure water jetting systems to erode the material adjacent to the pile when needed and permitted to facilitate driving the sheet piles to the desired penetration. The pumping capacity provided shall deliver a minimum of 150 psi pressure at each jet nozzle.

(c) The jetting may be done ahead of the actual driving operation or simultaneously with the driving operation. If jets and hammer are used simultaneously, the jets shall be withdrawn and the final penetration of the sheet pile obtained by driving with the hammer alone for at least the last foot of penetration.

(d) Payment for jetting sheet piles will not be made.

803.07 CUT-OFFS.

(a) The tops of sheet piling shall be cut-off or driven down to a straight line at the elevation indicated on the plans or as directed.

(b) If the heads of the sheet piles are appreciably distorted or otherwise

damaged below cut-off level, the damaged portions shall be removed and replaced at the contractor's expense.

(c) The tops of all timber sheet piles, after cut-off, shall be brush-coated with 2 applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch after which a cover of 20 gage galvanized iron sheeting, 6 inches wider than the overall thickness of the sheet piles, shall be bent down at least 3 inches on each side and nailed to the vertical surface of the sheet piles with large headed galvanized roofing nails.

(d) Any sheet pile damaged during driving by reason of internal defects or improper driving or which is driven either out of its proper position or below cut-off elevation shall be withdrawn and replaced with a new pile at the contractor's expense.

803.08 PAINTING. Before driving, the surfaces of steel sheet piling to be backfilled or immersed shall be satisfactorily cleaned and painted in accordance with the plans or as specified herein. Surfaces to be cleaned and painted will be from a point 10 feet below stream bed to cut-off level, unless otherwise directed. These surfaces shall be cleaned in accordance with Steel Structures Painting Council Specifications SP-10 and painted with 2 coats of Coal Tar Epoxy Paint conforming to Subsection 1008.13.

803.09 METHOD OF MEASUREMENT. The quantities of sheet pile wall for payment will be the design wall area as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, or if plan errors are proven, or if design changes are made.

803.10 BASIS OF PAYMENT. The accepted quantities of sheet pile wall will be paid for at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
803(1)	Untreated Timber Sheet Pile Wall	Square Foot
803(2)	Treated Timber Sheet Pile Wall	Square Foot
803(3)	Concrete Sheet Pile Wall	Square Foot
803(4)	Steel Sheet Pile Wall	Square Foot

Section 804

Bearing Piles

804.01 DESCRIPTION. This work consists of furnishing and driving piles of the kind and size designated, to the required penetration in accordance with these specifications and in reasonable close conformity with the lines and specings shown on the plans or established by the engineer.

804.02 MATERIALS.

(a) Precast Concrete Piles: Materials for precast concrete piles shall conform to Sections 901 and 1009.

(b) Cast-In-Place Concrete Piles: The steel in the shell or pipe shall conform to Subsection 1013.11, or to other shells as shown on the plans or in the project specifications. Concrete for cast-in-place concrete piles shall be Class A conforming to Section 901. Reinforcing steel shall conform to Section 1009.

(c) Timber Piles: Timber piles, treated or untreated, shall conform to Section 1014.

(d) Steel Bearing Piles: Steel bearing piles shall consist of structural steel shapes of the section specified, conforming to Subsection 1013.09.

(e) Piling furnished under items for "Concrete Piles" and "Unloaded Concrete Tests Piles" shall be either precast concrete piles or cast-in-place concrete piles at the contractor's option; however, the same type of pile shall be furnished under both these items for a project.

804.03 PREPARATION FOR DRIVING.

(a) Excavation: In general, piles shall not be driven until after the excavation is complete. Any material forced up between the piles shall be removed to correct elevation without cost to the Department before concrete for the foundation is placed.

(b) Embankment: Unless otherwise specified or shown on the plans, the embankment at bridge ends shall be constructed to the elevation of the bottom of the abutment bent cap and thoroughly compacted as provided for in Subsection 203.12 prior to driving the piles affected.

(c) Driving Caps: When the nature of driving is such that requires protection for heads of concrete and timber piles, the pile driving heads shall

be cushioned by an approved cap. The approved cap shall have a rope or other suitable cushion next to the pile head and fitting into a casting which supports a timber shock block. When the area of the head of any timber pile is greater than that of the face of the hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile.

Special driving heads, mandrels or other devices (in accordance with the manufacturer's recommendations) shall be provided for special types of piling so that the pile may be driven without injury.

For steel piling, the heads shall be cut squarely. A driving cap shall be provided during the driving sequence to hold the axis of the pile in line with the axis of the hammer.

(d) Collars: Collars, bands or other approved devices to protect timber piles against splitting or brooming shall be provided where necessary or as required by the engineer.

(e) Pointing: Timber piles or steel bearing piles shall be pointed where soil conditions require. The pointing shall be as approved by the engineer.

(f) Splicing Piles:

(1) Precast concrete piles shall be furnished and driven in full lengths, unless otherwise specified on the plans.

(2) Cast-in-place concrete pile shells may be field spliced, but sections which in the opinion of the engineer are too short shall not be used. Field splices of shell sections shall be made in accordance with the manufacturer's recommendations and to the satisfaction of the engineer. Welding shall conform to Section 815, except that the prequalification test for field welders will not be required unless specifically directed by the engineer.

(3) Steel bearing piles shall be furnished and driven in full lengths unless splices are specified or authorized. When authorized, splices shall be limited to not more than 2 per pile. Splicing of steel bearing piles shall be made by welding in accordance with Section 815.

(4) Timber piles shall be furnished and driven full length where practicable. Splicing of timber piles may be made only by written permission of the engineer and in accordance with the splicing detail furnished or approved by the engineer.

(g) Painting of Piling: Unless otherwise specified, foundation piling, either of steel or the steel shells of cast-in-place concrete piles, shall not be painted.

That area of steel piles, or the exterior surface of the steel shell of cast-in-place concrete piles, extending above the ground line or stream bed shall be satisfactorily cleaned and painted in accordance with Subsection 803.08 when required.

(h) Transportation of Precast Concrete Piling: Precast-prestressed concrete piles may be transported provided the piles are supported at each of the pick-up points as shown on the plans for the particular lengths of piling. The supports shall not be more than one foot from the theoretical position of each support, nor shall the distance between the two supports be more than one foot from the theoretical required distance between supports, unless otherwise approved by the engineer.

(i) Supporting Holes for Piles: When approved by the engineer, piles may be set in supporting holes but in no case shall the depth of the holes be more than 10 feet for piles up to 50 feet in length, or more than 20 percent of the designated penetration of the piles for piles over 50 feet in length. If additional support is required, templates or falsework above the ground shall be furnished. After the piles are driven, such supporting holes shall be backfilled to the level of the finished ground or base of footing, as the case may be, with a granular material acceptable to the engineer.

804.04 METHODS OF DRIVING.

(a) Description: Piles shall be driven with an approved type hammer that will obtain the required penetration without damaging the piles, except that gravity hammers will be permitted only when driving timber piles. The minimum energy to be developed by the hammer used shall be as shown for the various types of piles listed hereunder. In determining the suitability of diesel hammers, 85 percent of the rated energy will be used. One of the conditions of approval for a type of hammer proposed shall be that the pile capacity can be determined under the hammer by an acceptable formula.

(b) Hammers for Timber Piles: Gravity hammers for driving timber piles shall weigh not less than 2,000 pounds, preferably 3,000 pounds, but in no case shall the weight of the hammer be less than the combined weight of the driving head and pile. The fall shall be so regulated as to avoid injury to the piles and in no case shall it exceed 15 feet. When timber piles are driven with steam, air or diesel hammers, either single or double acting, the total energy developed by the hammer shall not be less than 7,200 nor more than 15,000 foot-pounds per blow.

(c) Hammers for Concrete Piles: Unless otherwise provided, precast concrete piles or shells for cast-in-place concrete piles shall be driven with an approved hammer which shall develop an energy at each full stroke of the piston of not less than 1 foot-pound for each pound of weight driven, except when the weight of the pile exceeds 48,000 pounds of the minimum size hammer shall be one developing 48,000 foot-pounds of energy. In no case shall the total energy developed by the hammer be less than 15,000 foot-pounds per blow. When there is little resistance to driving, a hammer of lesser energy than specified above may be required to prevent damage to the piling.

(d) Hammers for Steel Piles: Unless otherwise provided, steel piles shall be driven with an approved hammer developing an energy of not less than 1 foot-pound for each pound of weight driven. The minimum energy shall be developed at each full stroke of the piston. The total energy developed by the hammer shall be no less than 15,000 foot-pounds per blow.

(e) Additional Equipment: In case the required penetration of the pile is not obtained by the use of a hammer complying with the above requirements, the contractor shall, with approval of the engineer, resort to one or both of the following listed methods in combination with the hammer.

1. Use pilot holes.
2. Use water jets.

(f) Leads, Templates or a Combination Thereof: Equipment shall be constructed in such manner as to afford freedom of movement of the hammer and to drive piles to the tolerances specified without injury to the piles. Either fixed leads or swinging leads may be used. Swinging leads, when used, shall be in combination with a rigid template which provides pile support that meets the approval of the engineer. Inclined leads shall be used in driving batter piles.

(g) Followers and Underwater Hammers: The use of followers or underwater hammers for driving piling shall be permitted by written approval of the engineer. When a follower or underwater hammer is used, 1 pile in each group of 10 shall be furnished sufficiently long to permit being driven without a follower or underwater hammer and shall be used as a test pile to determine the average bearing power of the group. Test piles so designated will not be classified as such nor will any payment be made for load tests.

(h) Pilot Holes: Pilot holes required or permitted during driving of permanent piles shall be bored or dug to sufficient size and depth to permit pile penetration into hard soil. In general, pilot holes shall have a diameter equal to ⅞ the face width of a square pile or ⅞ the average diameter of a round pile but shall, however, be of a size which will provide the desired results. The pile will then be driven to the required penetration and bearing capacity. Any resulting open space around the pile shall be filled with granular material acceptable to the engineer.

In no case shall the pilot hole extend to within 5 feet of the tip elevation of the pile, unless authorized by the engineer.

(i) Pilot Holes in Embankments: Where specified, pilot holes shall be used in embankments. In general, pilot holes shall have a diameter 4 inches greater than the diagonal of a square piling and 6 inches greater than the diameter of a round piling. The depth of the pilot hole shall be equal to the embankment height. The pile will then be placed within the pilot hole and driven to the required penetration and bearing capacity. The annular

space around the piles shall be filled with granular material acceptable to the engineer at the contractor's expense.

(j) Water Jets: When water jets are required or allowed, the number and size of jets and the volume and pressure of water at the jet nozzles shall be sufficient to erode the material adjacent to the pile. The pump shall have sufficient capacity to deliver at all times at least 150 pounds per square inch pressure at two ¾-inch jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration. Jetting shall not be permitted within 5 feet of the tip elevation of the pile unless authorized by the engineer. The use of jets where the stability of embankments or other improvements would be endangered will not be permitted.

(k) Accuracy of Driving: All piles shall be driven at locations as shown on the plans or as ordered in writing by the engineer. In pile bents the centroid of any pile at cut-off elevation shall not vary from the plan location by more than 3 inches measured perpendicular to the bent, nor more than 6 inches measured along the centerline of the bent, and the piles shall be driven with a variation of not more than ¼ inch per foot from the vertical or from the batter shown on the plans. For foundation piling, the centroid of any pile at cut-off shall be within a 12 inch diameter circle having the plan location as its center.

(l) Interrupted Driving: When driving is interrupted before the pile reaches final penetration, the record for resistance shall not be taken until after at least 12 inches of penetration has been obtained after driving is resumed.

(m) Extent of Driving: Driving shall be continued until plan cut-off is reached or until satisfactory penetration and resistance are obtained. If desired resistance to driving is not obtained at plan cut-off, the engineer has the option of either loading a permanent pile to determine the capacity or the driving may be continued until satisfactory resistance is obtained, and the additional length of pile required shall be supplied by splicing. Precast concrete piles shall be extended in accordance with Subsection 804.11.

(n) Loading Permanent Piles: A permanent pile which does not attain the desired resistance to driving shall be loaded when so directed by the engineer. The loading procedure shall be in accordance with Subsection 804.09(b).

804.05 CAST-IN-PLACE CONCRETE PILES. Cast-in-place concrete piles shall be steel encased. Steel casings or shells shall be of the diameter and type shown in the plans or project specifications. After shells are driven to required penetration and any required reinforcing steel is placed, shells shall be filled with concrete, subsequent to their inspection and approval. The contractor shall provide suitable light for inspection of each shell

after it has been driven to required penetration. The shell shall be cleaned of all debris and pumped dry before placing concrete.

Class A concrete conforming to Section 901 shall be placed in the shell. Concrete shall be handled by an approved method and in such manner as to prevent segregation. All piles shall be filled with concrete to the cut-off elevation. Reinforcing steel, when required, shall be of the size and spacing shown on the plans and shall be securely fastened together so as to form a rigid cage. Care shall be taken to hold the reinforcement in true relative position during the filling of the piles. Concrete blocks or suitable devices may be used to prevent the displacement of the reinforcement cage. Concrete in the shell shall be vibrated from the lower end of the reinforcing cage to the top of the pile. When reinforcing steel is not required, concrete in the top 10 feet of the shell shall be vibrated. Driving of additional piles within a radius of 10 feet of the completed pile will not be permitted until the concrete has been allowed to set for at least 36 hours.

Shells for cast-in-place concrete piles shall be of sufficient thickness and strength so that the shell will hold its original form and show no harmful distortion after it has been driven, and the driving mandrel, if any, has been withdrawn. It shall be the contractor's responsibility to determine the wall thickness of shell required.

804.06 DEFECTIVE PILES. The procedure used in the driving of piles shall not subject them to excessive and undue abuse producing cracking, crushing or spalling of the concrete, injurious splitting, splintering and brooming of the wood or deformation of the steel. Manipulation of concrete piles to force them into proper position will not be permitted. Any pile found to be unacceptable due to internal defects, by improper driving, driven out of its proper location, driven below the elevation fixed by the plans or by the engineer shall be corrected at the contractor's expense by one of the following methods approved by the engineer for the pile in question:

1. The pile shall be withdrawn and replaced by a new and, if necessary, a longer pile.

2. A second pile shall be driven adjacent to the defective pile.

3. The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to embed the pile. Timber piles shall not be spliced without permission of the engineer. All piles pushed up by the driving of adjacent piles or by any other cause shall be redriven to the desired elevation.

4. The cap or footing shall be redesigned at no cost to the Department and shall be approved by the engineer. Additional compensation will not be allowed the contractor for increased quantities in a bent or footing due to driving additional piles to correct defective piles.

804.07 DETERMINING PILE BEARING CAPACITY.

(a) General: A pile's bearing capacity will normally be determined by comparing penetration, theoretical bearing values, loading conditions and soil borings with similar conditions known from a representative test pile previously driven. Where results are obtained through variation in soil conditions and other factors which makes the pile bearing capacity questionable or does not offer a ready comparison to available information, test loading will be required. The test shall consist of applying a static test load placed upon a suitable platform supported by the pile. The platform must be equipped to accurately measure the test load and the settlement of the pile under each increment of load. In lieu thereof, hydraulic jacks with suitable yokes and pressure gages may be used.

The test load shall be applied in the various increments as specified. If hydraulic jacks are used to apply the load, they will be calibrated by the Laboratory provided the transporting of the jacks to and from the Laboratory is furnished by the contractor and, further, that the Laboratory has the necessary equipment to conduct the tests; otherwise the contractor shall have the jacks calibrated by a reputable commercial laboratory, in which case certified laboratory reports of the calibration tests shall be furnished to the Department Laboratory. When two or more hydraulic jacks are used they shall be connected in parallel by means of a manifold or other device so as to allow the same pressure in all lines leading to the jacks. All jacks must be of the same type and capacity. The gage for determining the pressure shall be placed between the pump and the manifold or other device used to direct the flow of fluid to the jacks. This gage shall be calibrated to give a direct reading in tons of the total load placed on the test pile.

(b) When required, the contractor shall make load tests for the purpose of determining the bearing capacity of piling. Unless otherwise provided, anchor piles shall be at least 5 feet from the test pile.

The contractor shall submit to the engineer, for approval, his proposed method to test load the required piles.

(c) Pile Formulas: If the safe bearing capacity of piles is to be determined by formulas, the following shall be used as a guide:

$$P = \frac{2WH}{S + 1.0} \quad \text{for gravity hammer,}$$

$$P = \frac{2WH}{S + 0.1} \quad \text{for single-acting steam or air hammers,}$$

Where

P = safe bearing power in pounds,
W = weight in pounds of striking parts of hammer,
H = height of fall in feet,
S = the average penetration in inches per blow for the foot involved.

The above formulas are applicable only when:

(1) The hammer has a free fall.

(2) The head of the pile is not broomed or crushed.

(3) The penetration is reasonably quick and uniform.

(4) There is no appreciable bounce after the blow.

(5) A follower is not used.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

Diesel hammers will be permitted. The hammer must be equipped with some means of measuring the height of fall of the ram or measuring the chamber pressure. The contractor shall provide charts or information for converting measured energy or height of fall to bearing capacity.

804.08 TEST PILES.

(a) When required, the contractor shall drive test piles of the length, number, size and type specified at the location and penetration shown on the plans or as directed.

If water jets are used in connection with the driving, the bearing capacity will be determined by the applicable formulas from the results obtained by driving after the jets have been withdrawn or by static load testing in accordance with Subsection 804.09.

Test piles shall be driven using the same type of hammer, the same energy, methods and procedures as intended for permanent piles.

(b) When test piles are driven to determine the length of foundation piles required, it will be necessary to excavate a hole from the natural ground to the elevation of the bottom of footing and to keep this hole open during driving and loading of test piles so that driving and loading conditions will be representative of actual conditions of load on the permanent piles. In lieu of the above, the contractor will be permitted to drive the test pile within an approved casing. The casing shall extend to the bottom of footing or to the elevation shown on the plans. The contractor shall, at his own expense, provide any bracing of the test pile that may be required during loading or driving operations.

(c) Cast-in-place concrete test piles shall be filled with concrete in accordance with Subsection 804.05 and the concrete allowed to set for at least 48 hours before the first increment of test load is applied.

(d) The plans or project specifications will designate whether or not permanent piles are to serve as test piles. Should a permanent pile so designated fail under the test load, and should redriving be required, the following requirements shall apply:

1. Precast concrete piles shall not be spliced and redriven unless otherwise permitted. If directed by the engineer, the contractor shall remove the failing pile and drive a new test pile to the designated depth at the approved location.

2. Steel bearing piles shall have an additional length spliced, if necessary, and the pile redriven to such further depth as may be directed.

3. Timber piles shall not be spliced and redriven. If directed by the engineer, the contractor shall remove the failing pile and drive a new test pile to the designated depth at the approved location.

4. Cast-in-place concrete piles shall not be redriven except by written permission. If ordered, the contractor shall drive a new test pile to the designated depth and at the designated location.

(e) If test piles are not to be utilized as permanent piles, they shall be removed to a minimum of one foot below natural ground or stream bed and disposed of as directed.

(f) If permanent piles are used for anchor piles, the permanent pile will be no lower than the tip elevation of the test pile and, after completion of test pile installation, the permanent pile shall be reseated.

804.09 LOADING PILES.

(a) Loading Test Piles: Unless otherwise specified, test piles shall be allowed to remain undisturbed for at least 14 days after driving to required penetration before beginning loading operations. Test piles shall be loaded to failure or until 2½ times the design load is reached.

The first increment of load to be placed on the test pile shall be the pile design load. The load on the pile shall then be increased to 2½ times the design load by adding an additional load in 6 equal increments. A period of 2 hours shall intervene between each increment of load, except that if the pile is still settling at the end of the 2-hour period, the interval may be extended at the discretion of the engineer.

Upon attaining 2½ times the design load on the pile or upon finding a gross settlement ¼ inch greater than the elastic deformation, the loading shall be halted and the pile allowed to stand under this load of a period of 2 hours or until settlement stops or failure is reached. The load shall then be removed and the pile allowed to stand for at least 2 hours without any load. Readings will be taken to determine the amount of rebound and the net settlement.

The safe allowable load of any pile so tested shall be considered equal to ½ the maximum load reached before failure occurs, or equal to ½ that load which does not cause a greater permanent settlement than ¼ inch measured at the top of the pile.

(b) Loading Permanent Piles: When loading of permanent piles is

directed by the engineer, the loading shall be conducted in accordance with the following procedure. The pile shall be allowed to stand undisturbed for at least 14 days before beginning loading operations. Permanent piles shall be loaded to failure or until a load equal to twice the design load is reached.

The first increment of load to be placed on the pile shall be the pile design load. The load on the pile shall then be increased to twice the design load by adding the additional load in 3 equal increments. A period of 1 hour shall elapse between each increment of load, except that if the pile is still settling at the end of the 1-hour period, the interval shall be extended. Upon attaining twice the design load on the pile or upon finding a gross settlement ¼ inch greater than the elastic deformation, the loading shall be halted and the pile allowed to stand under this load for a period of 1 hour.

The safe allowable load of any pile so tested shall be equal to ½ the maximum load reached before failure occurs, or equal to ½ of that load which does not cause a greater permanent settlement than ¼ inch measured at the top of the pile.

804.10 ORDER LISTS FOR PILING. The contractor shall furnish piles in accordance with an itemized list, which will be furnished by the engineer, showing the number, size, length and location of all permanent piles. No permanent piles shall be driven prior to receipt of this order list. When test piles are driven to determine the lengths of piling, the order list will not be furnished the contractor until the loading is completed and the order lengths approved. The engineer may require that the permanent piles be driven to a tip elevation below that of the test pile even though the test pile satisfactorily withheld the test load. In determining lengths of piles for ordering, the lengths given in the order list will be based on the lengths which are assumed to remain in the completed structure. The contractor shall, at his own expense, increase the lengths given to provide for fresh heading and for such additional length as may be necessary to suit the contractor's method of operation. The order length may be revised by the engineer when actual driving conditions deviate from test pile results.

804.11 EXTENSION OF PRECAST CONCRETE PILES.

(a) Extending by Casting in Place: The plans show the length of reinforcing steel to be exposed and the additional size and number of reinforcing bars to be spliced where pile extensions are required. The final cut of the concrete shall be perpendicular to the axis of the pile. Concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be thoroughly wet and covered with a thin coating of neat cement or other suitable bonding material. All materials used shall conform to Sections 901 and 1009.

(b) Extending by Splicing a Precast Section: When permitted or required on the plans, a precast concrete pile may be extended by the addition of a precast section with splicing to be done by an approved method or

as shown on the plans. The section added on shall meet all requirements of these specifications.

804.12 CUT-OFFS.

(a) Precast Concrete Piles: Cut-offs for precast concrete piles shall be made perpendicular to the axis of the pile at the elevation shown on the plans or as directed. Care shall be exercised to avoid unnecessary spalling of the concrete. The reinforcement thus exposed shall remain to engage the body of the footing or cap as the case may be.

(b) Steel Bearing Piles: Steel bearing piles shall be cut off at right angles to the axis of the pile and to the elevation shown on the plans or as directed. The cuts shall be made in clean straight lines and any irregularity due to cutting or burning shall be corrected by deposits of weld material prior to placing bearing caps, should such be required.

(c) Timber Piles:

(1) The tops of timber piling which support concrete footings or concrete caps shall be sawed off at right angles to their axis at the elevation shown on the plans or as directed.

(2) Piles which support timber caps shall be sawed to a horizontal plane, or to the slope specified, in such manner as to fit the superimposed structure.

(3) Shimming on tops of piles will not be permitted.

(4) The treatment of pile heads shall conform to Section 812.

(d) Cast-in-place Concrete Piles: When pile shells are fully driven, inspected and approved, they shall be neatly cut off at right angles to the axis of the pile at the required cut-off elevation.

804.13 METHOD OF MEASUREMENT.

(a) Pilings: Piling driven in the locations designated on the plans will be measured by the linear foot of pile, complete in place, below cut-off elevation. This measurement will include the redriving of permanent piles that are used for anchor piles in accordance with Subsection 804.09.

(b) Cut-offs: Cut-offs made as directed will be measured by the linear foot. Payment will not be made for the cut-off of any pile unless the length of such cut-off is in excess of one linear foot, nor will payment for cut-offs be made where they have been necessitated by crushing, brooming, splitting or other injuries resulting from careless driving.

No payment will be made for required cut-offs of steel bearing piling and cast-in-place concrete pile shells; such cut-offs will remain the property of the contractor.

(c) Cast-in-Place Extensions: Measurement of extensions on precast concrete piles including test piles, will be made by the linear foot, com-

plete in place and accepted. Measurement will be made as follows: the length of cut-back on the ordered length of pile will be added to the net length of extension to obtain the gross length of extension; the gross length of extension will then be multiplied by 3 to determine the quantity for measurement, which measurement shall include any additional driving required. This additional driving includes any moving back and redriving of permanent piles as directed by the engineer. No deduction will be made from the ordered length of pile driven due to cut-back for splicing.

Measurement of extensions on all other types of piles will be made by the linear foot complete in place and accepted for that portion of the pile added to the original length of pile driven, which measurement shall include any additional driving that may be required.

No measurement will be made for extensions necessitated by damage to the pile during driving.

(d) Redriving Test Piles: Redriving of test piles will be measured for each test pile for which redriving is required.

(e) Splices:

(1) Concrete Piles: Splices for precast concrete piles will not be measured as a splice.

(2) Timber Piles: Measurement of splices on timber piles will be by the linear foot. The total number of linear feet of piling driven will be determined by adding 10 feet to the net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(3) Steel Bearing Piles: Measurement of splices on steel bearing piles will be made by the linear foot. The total number of linear feet of piling driven will be determined by adding 2 feet to the net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(4) Cast-in-place Concrete Piles: Splices for cast-in-place concrete piles will not be measured as a splice.

(f) Test Piles: The number of test piles to be paid for will be the number of individual piles of each type furnished and driven as directed. Cut-offs of test piles will not be included in any pay footage. Test piles pulled and re-used as permanent piles will be measured as provided under paragraph (a).

(g) Loading Test Piles: The number of load tests to be paid for will be the number of load tests ordered and completed.

(h) Reloading Test Piles: The number of reload tests to be paid for will be the number of reload tests ordered and completed.

(i) Loading Permanent Piles: The number of load tests to be paid for

will be the number of load tests made as directed by the engineer, completed and accepted.

804.14 BASIS OF PAYMENT.

(a) Piling: The accepted quantities of piling will be paid for at the contract unit price per linear foot which includes all materials, labor and incidentals required for bolting, wrapping or fastening timber fender piles and shall include the cost of driving batter piles specified on the plans and shall include the concrete and reinforcing steel in cast-in-place concrete piles and will include any jetting or pilot holes required. This price shall also include the redriving of permanent piles that are used for anchor piles.

(b) Cut-offs: Payment for cut-offs will be made at the rate of ⅔ the contract unit price per linear foot for the particular type of pile which has been cut off.

(c) Extensions: Payment for cast-in-place extensions will be made at the contract unit price per linear foot for the type and size of pile being extended.

(d) Splices: Payment for splices will be made at the contract unit price per linear foot for the particular type of pile spliced.

(e) Test Piles: Test piles will be paid for at the contract unit price per each.

(f) Loading Test Piles: Loading test piles will be paid for at the contract unit price per each.

(g) Reloading Test Piles: Reloading test piles will be paid for at the contract unit price per each.

(h) Loading Permanent Piles: Loading permanent piles will be paid for at the contract unit price per each.

(i) Redriving Test Piles: Redriving test piles will be paid for at the contract unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
804(1)	Precast Concrete Piles (Size)	Linear Foot
804(2)	Untreated Timber Piles	Linear Foot
804(3)	Treated Timber Piles	Linear Foot
804(4)	Steel Bearing Piles (Size)	Linear Foot
804(5)	Cast-in-Place Concrete Piles (Size)	Linear Foot
804(6)	Concrete Piles	Linear Foot
804(7)	Precast Concrete Test Piles	Each
804(8)	Timber Test Piles	Each
804(9)	Steel Bearing Test Piles	Each
804(10)	Cast-in-Place Concrete Test Piles	Each
804(11)	Concrete Test Piles	Each

Item No.	Pay Item	Pay Unit
804(12)	Loading Test Piles	Each
804(13)	Reloading Test Piles	Each
804(14)	Redriving Test Piles	Each
804(15)	Loading Permanent Piles	Each

Section 805

Structural Concrete

805.01 DESCRIPTION. This work consists of furnishing, placing, finishing and curing portland cement concrete in bridges, culverts and miscellaneous structures in accordance with these specifications and conform to the lines, grades and dimensions shown on the plans.

805.02 MATERIALS. Materials shall conform to the following Sections or Subsections.

Portland Cement Concrete	901
Adhesives	1011.03
Reinforcing Steel	1009
Joint Sealers	1005.02-1005.04
Joint Fillers	1005.01
Elastomeric Bearing Pads	1017.14
Curing Materials	1011.01
Special Surface Finish Materials	1011.04

805.03 CLASSES OF CONCRETE. Each class of concrete shall be used in that part of the structure where called for on the plans or when designated. The following requirements shall govern unless otherwise specified.

Class A concrete shall be used except where another class is specified.

Class A(M) concrete shall be used in lieu of Class A concrete when specified.

Class AA concrete shall be used for all concrete in bridge superstructure that is poured in place. Class AA concrete may be substituted for Class A concrete at the contractor's option.

Class AA(M) concrete shall be used in lieu of Class AA concrete when specified. At the contractor's option, Class AA(M) concrete may be substituted for Class A(M) concrete.

Class D concrete shall be used for pier footings and for nonreinforced sections.

Class P concrete shall be used for precast-prestressed bridge members.

Class P(M) concrete shall be used in lieu of Class P concrete when specified. At the contractor's option, Class P(M) concrete may be substituted for Class P concrete.

Class R concrete shall be used for revetments and for other nonreinforced sections.

Class S concrete shall be used for all sections deposited under water.

Class X concrete may be used for nonprestressed precast bridge members in lieu of Class P concrete when such an option is allowed by the plans and project specifications.

805.04 HANDLING AND PLACING CONCRETE.

(a) General: In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations shall be removed from the forms when the concrete placing has reached an elevation rendering their service unnecessary.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under Subsection 901.12.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the engineer. In case an inferior quality of concrete is produced by the use of such devices, the engineer may order discontinuance of their use and the institution of a satisfactory method of placing.

Unless otherwise permitted, open troughs and chutes shall be of metal or metal-lined. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement of the concrete.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each pour; water used for flushing shall not be discharged within the structure. No aluminum alloy material will be allowed.

When placing operations would involve dropping the concrete more than 5 feet, it shall be deposited through sheet metal or other approved tremie except where deemed impractical by the engineer. After initial set of the concrete the forms shall not be jarred; no strain shall be placed on the ends of reinforcement bars which project from freshly poured concrete.

Concrete, during and immediately after depositing, shall be thoroughly consolidated. The consolidation shall be done by mechanical vibration subject to the following provisions.

(1) The vibration shall be internal unless special authorization of other methods is obtained or as provided herein.

(2) Vibrators shall be of an approved type and design. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.

(3) The intensity of vibration shall be such as to visibly affect the mass of concrete over a radius of at least 18 inches.

(4) The contractor shall provide a sufficient number of vibrators to properly consolidate each concrete batch immediately after it is placed in the forms.

(5) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

(6) Vibration shall not be applied indirectly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation. Vibrators shall not be used to transport concrete in the forms.

(7) Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

(8) These provisions for vibration shall apply to filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

(9) These provisions for vibration shall also apply to precast piling, concrete cribbing and other precast members except that, if approved, the manufacturer's methods of vibration may be used.

Concrete shall be placed in horizontal layers not more than 12 inches thick unless otherwise permitted by the engineer. When less than a complete layer is placed in one operation, it shall be terminated at a vertical bulkhead. Each layer shall be placed and consolidated before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. The top surface of the concrete adjacent to the forms shall be finished to a 2-inch grade strip.

Where a "featheredge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an inset form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 6 inches in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face, unless provision has been made for a coping less than 18 inches thick, in which case, if permitted, the construction joint may be made at the underside of the coping.

Immediately following the discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be mixed in the fresh concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel-bond while cleaning the reinforcement steel.

(b) Reinforced Concrete Box Culvert: When specified by the plans or project specifications, the contractor shall have the option of furnishing structures of either cast-in-place concrete or precast concrete units. In general, for the cast-in-place option, the base slab or footings of a box culvert shall be placed and allowed to set before the remainder of the culvert is constructed.

Before concrete is placed in the sidewalls, the culvert footings shall be thoroughly cleaned of shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped or roughened in accordance with the method of bonding construction joints as specified in Section 805.07.

In the construction of box culverts 4 feet or less in height, the walls and top slab may be constructed as a monolith. When this method of construction is used, necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In the construction of box culverts more than 4 feet in height, the concrete in the walls shall be placed and allowed to set in accordance with strength or curing time requirements of Subsection 805.11 before the top slab is placed.

If possible, each wing wall shall be constructed as a monolith. Construction joints, where required, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

Precast units shall be cast and placed as shown on the plans. Joints for sec-

tional precast units shall be sealed with a flexible plastic gasket material conforming to Subsection 1006.02 so installed as to form a watertight seal.

(c) **Girders, Slabs and Columns:** Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. For continuous spans, where required by design considerations, the concrete placing sequence shall be as specified in the plans or project specifications.

Concrete in girder haunches less than 3 feet in height shall be placed at the same time as that in the girder stem, and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of 3 feet or more, the abutment or columns, the haunch and the girder shall be placed in 3 successive stages; first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion. For haunched continuous girders, the girder stem (including haunch) shall be placed to the top of stem. Where the size of the pour is such that it cannot be made in one continuous operation, vertical construction joints shall preferably be located within the area of contraflexure.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise directed.

The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case, special shear anchorage shall be provided to insure monolithic action between girder and floor.

Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in 2 separate operations, each of which shall be continuous; first, to the top of the girder stems; and second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and may be secured by means of suitable shear keys or by artificially roughening the surface of the top of the girder stem. In general, suitable keys may be formed by the use of timber blocks approximately 2 by 4 inches in cross-section and having a length 4 inches less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall not be greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal, and they shall be removed as soon as the concrete has set sufficiently to retain its shape.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least 24 hours before the caps are placed. When friction collars are used to support cap forms, the concrete for columns shall have been poured at least 7 days or shall have at least 3,000 psi compressive strength before caps are placed.

Unless otherwise permitted, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine

the character of the concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until the test cylinders representing the bent have attained at least 3,000 psi compressive strength but in no case in less than 7 curing days.

(d) Arches: The concrete in arch rings shall be placed in such manner as to load the centering uniformly.

Arch rings shall be cast in transverse sections of such size that each section can be cast in a continuous operation. The arrangment of the sections and the sequence of concrete placement shall be as approved and shall be such as to avoid the creation of initial stress in the reinforcement. The sections shall be bonded together by suitable keys or dowels. When permitted, arch rings may be cast in a single continuous operation.

(e) Minimum Placement Rate for Bridge Decks: The contractor shall provide sufficient supervision, manpower, equipment, tools and materials to assure proper production, placement and finish of concrete for each pour in accordance with the minimum placement rates as specified herein or as specified in the plans or project specifications. If the contractor fails to meet the specified minimum placement rate requirements, the engineer may reject the pour, and further placement of similar nature and size will not be permitted until corrective measures have been taken to assure the engineer that the specified minimum placement rate requirements can be met.

Pour Size Cubic Yards	Minimum Placement Rate Cubic Yards Per Hour
0 - 25	15
26 - 50	20
51 - 75	25
76 - 125	30
Over 125	40

805.05 PUMPING. Pumping equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. Pipes carrying concrete from the pump to the placing area should be laid out with a minimum of bends and with no unauthorized change in size. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The use of aluminum pipe as a conveyance for the concrete will not be permitted.

A grout mortar or regular concrete with coarse aggregate omitted shall be pumped through the equipment ahead of the regular concrete to provide lubrication to start pumping operations. This material shall not be used in placement. The lubrication process will not be repeated as long as the pumping operations are continuous.

The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

805.06 DEPOSITING CONCRETE UNDER WATER. Concrete shall not be deposited in water except on approval, and the method of placing shall be as designated below:

Concrete deposited in water shall be Class S. To prevent segregation, it shall be carefully placed in a compact mass in its final position by means of a tremie, or other approved method, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and the forms under water shall be watertight.

For parts of structures under water, when possible, concrete seals shall be placed continuously from start to finish.

A tremie shall consist of a tube having a diameter of not less than 10 inches, and if constructed in sections, it shall have watertight couplings. The tremies shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be entirely sealed.

When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed. Aluminum tremies will not be permitted.

Dewatering may proceed when the concrete is sufficiently hard and strong, but not for a period of at least 72 hours after placing the concrete. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping or other means which will not injure the surface of the concrete.

805.07 CONSTRUCTION JOINTS.

(a) General: Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved.

If not detailed on the plans, construction joints shall be placed as directed. Raised shear keys or reinforcing steel shall be used where necessary to transmit shear or bond the the 2 sections together.

(b) Bonding:

(1) Construction Joints: Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened as required and

in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance and saturated with water. To insure an excess of mortar at the juncture of the hardened and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be thoroughly covered with a coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained its initial set. The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished true to line and elevation.

(2) Epoxy Joints: Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The vertical surfaces of the deck construction joints and other construction joints as specified elsewhere shall be coated prior to each succeeding pour with an epoxy adhesive conforming to Subsection 1011.03, applied according to the manufacturer's recommendations. The surface of the joint of old concrete to which new concrete is to be bonded shall be cleaned by sandblasting, hammers or wire brushes so that all foreign material and loose and unsound concrete is removed and only sound concrete remains. If grease or oil are present, they shall be removed with a detergent wash such as trisodium phosphate and the entire area then washed with fresh water and brushed with a stiff brush. If a detergent is not required, washing will only be required as necessary to remove dust and small particles not removed by other cleaning methods.

805.08 CONCRETE EXPOSED TO SEA WATER. Unless otherwise provided, concrete for structures exposed to sea water shall be Class A concrete. The concrete shall be mixed for a period of not less than 2 minutes and the water content of the mixture shall be carefully controlled and regulated so as to produce concrete of maximum impermeability. The concrete shall be thoroughly consolidated and stone pockets shall be avoided. No construction joints shall be formed between levels of extreme low water and extreme high water as determined by the engineer. Between these levels sea water shall not come in direct contact with the concrete for a period of not less than 30 days. The original surface, as the concrete comes from the forms, shall be left undisturbed.

805.09 FALSEWORK AND CENTERING. Detailed plans for falsework and centering shall be furnished in accordance with Section 801.

For designing falsework and centering, a weight of 150 pounds per cubic foot shall be assumed for green concrete and a minimum of 30 pounds per square foot for construction load. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. The engineer may require the contractor to employ screw jacks, hardwood wedges or other approved methods to take

up any settlement in the formwork either before or during the placing of concrete.

Falsework which cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven and removed in an approved manner.

Falsework shall be set to give the finished structure the camber specified or indicated on the plans.

Arch centering shall be constructed according to approved centering plans. Provisions shall be made by means of suitable wedges, sand boxes or other devices for the gradual lowering of centers to render the arch self-supporting. When directed, centering shall be placed upon approved jacks in order to take up and correct any slight settlement which may occur after the placing of concrete has begun.

805.10 FORMS.

(a) Construction: Forms shall be of wood, metal, or other approved material and shall be built mortartight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the lumber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

(b) Form Surface: Forms for exposed surfaces shall not adhere or discolor the concrete and shall be made of either metal or dressed lumber of uniform thickness with or without form liner of an approved type, and mortartight. Forms for reentrant angles shall be chamfered and the forms shall be filleted at all sharp corners. The forms shall be given a bevel or draft in the case of all projections, such as girders or copings, to insure easy removal.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit free access for the purpose of inspecting, working and spading the concrete.

(c) Metal Ties: Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least ½ inch from the face without damage to the concrete. In case ordinary wire ties are permitted, all wires upon removal of the forms shall be cut back at least ¼ inch from the face of the concrete with chisels or nippers; for green concrete, nippers are necessary. Fittings for metal ties shall be of such design that upon their removal the cavities which are left will be of the smallest possible size. The cavities shall be filled with cement mortar and the sur-

face left sound, smooth, even and uniform in color.

(d) Setting and Maintaining: All forms shall be set and maintained reasonably true to the line and grade designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be determined as specified. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the work shall be stopped until the defects have been corrected. The forms shall be so designed that portions where finishing is required may be removed without disturbing portions of forms which are to be removed later and, as far as practicable, so that form marks will conform to the general lines of the structure. For narrow walls and columns, where the bottom of the form is inaccessible, the lower form boards shall be left loose so that they may be removed for cleaning out extraneous material immediately before placing the concrete.

(e) Re-Use: The shape, strength, rigidity, mortartightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber must be re-sized before being re-used. Forms which are unsatisfactory in any respect shall not be re-used.

(f) Surface Treatment: All forms shall be treated with a form-release agent and saturated with water immediately before placing the concrete. Any release agent which will adhere to or discolor the concrete shall not be used.

Prior to placing the concrete, the interior of all forms shall be cleaned of all dirt, sawdust, shavings or other debris. Forms shall be inspected immediately prior to placing concrete.

Cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

805.11 REMOVAL OF FALSEWORK, FORMS AND HOUSING. Except as herein provided, forms for surfaces required to be finished shall be removed when the concrete has aged not less than ½ nor more than 2 curing days after the concrete is placed to allow finishing.

The following specifications for the removal of forms and falsework shall apply to the forms and falsework under supporting members such as the portions of slabs that cantilever more than one foot beyond the outside beams, to the forms and falsework under girders and to the forms and falsework under bent caps of framed bents.

Forms and falsework for the portions of structures which do not require surface finishing shall be removed in accordance with either of the following methods, as the contractor elects.

Method 1: Forms and falsework may be removed as soon as the concrete has attained a compressive strength, as determined by cylinder tests, indicated in the following table:

Class of Concrete	Compressive Strength (psi)
A	3,000
A(M)	3,600
AA	3,200
AA(M)	3,600
D	2,500
X (nonprestressed)	2,500
P (nonprestressed)	3,000
P(M) (nonprestressed)	3,600

Test specimens shall be made in accordance with DOTD Designation: TR 226 from the same concrete and cured under the same conditions as the portion of the structure involved. Specimens will be tested in accordance with AASHTO Designation: T 22.

Method 2: Forms and falsework may be removed when the concrete has aged for the minimum number of curing days set forth in the following table:

Under slabs, beams or pile caps having span length of 10 feet and less.	7 days
Under slabs, beams or pile caps having span lengths over 10 feet and less than 17 feet.	7 days plus one day for each foot of span over 10 feet
Under slabs, beams or pile caps having spans over 17 feet in length	14 days
Under portion of slabs that cantilever more than one foot beyond outside beams.	7 days
Walls, columns, side forms for beams, pile caps and slabs that cantilever one foot or less beyond outside beam.	1 day
Concrete caissons.	1 day
Precast units (side forms)	1 day

The term "curing day" will be interpreted as any calendar day on which the temperature is above 50°F for at least 19 hours. Colder days may be counted if satisfactory provision is made to maintain the air temperature adjacent to the concrete constantly above 50°F throughout the entire day.

During continued cold weather, when artificial heat is not provided, the engineer may permit the removal of forms and falsework at the end of a period of calendar days equal to twice the number of curing days stated in the table.

In determination of the time for the removal of forms and falsework and the discontinuance of heating, consideration shall be given to the location and the character of the structure, the weather and other conditions influencing the setting of concrete.

The foregoing provisions relative to forms and falsework removal, under either method the contractor elects to use, shall apply only to forms or parts of forms which are so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structure.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

In general, arch centering shall be struck and the arch made self-supporting before the railing or coping is placed. This precaution is essential in order to avoid jamming of the expansion joints and variations in alignment. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure. In arch structures of 2 or more spans, the sequence of striking centers shall be specified or approved.

805.12 CURING CONCRETE. Concrete in substructures for grade separation structures, superstructures of major structures, and railroad underpasses shall be cured with wet burlap or other approved material. Precast concrete products shall be cured in accordance with Subsection 805.15.

A clear membrane curing solution with a fugitive dye may be used for curing concrete in minor drainage structures and bridge substructures and diaphragms when surfaces do not require a Class 2 or 2A finish. The curing compound shall conform to AASHTO Designation: M 148, Type 1-D. When membrane curing is used, exposed reinforcing steel and construction joint surfaces shall be covered or shielded to prevent coating with the curing compound. Construction joint surfaces shall be wet cured by approved methods and this curing shall begin as soon as possible after the concrete placement. Concrete surfaces in contact with forms shall be sealed immediately after completion of form removal and surface finishing. Membrane curing shall be applied as soon as the surface moisture has evaporated. The method and rate of application of curing compound shall be in accordance with manufacturer's recommendations, but in no case shall the application rate be less

than one gallon per 100 square feet of surface area. The compound shall be applied in one or two applications. If the compound is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and direct the application of the curing compound on the concrete surface so as to result in a uniform coverage.

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the compound shall be applied to the affected portions.

When curing with burlap is required, the exposed concrete immediately after finishing shall be covered with two thicknesses of wet burlap. The burlap shall be kept continuously and thoroughly wet for a period of not less than 5 days after the concrete is placed.

In bridge deck construction the exposed surface of the desk shall be sprayed uniformly with an approved curing compound immediately after final texturing as an interim curing measure in accordance with Subsection 601.12(c). Exposed reinforcing steel and joints shall be covered or shielded to prevent contact with the curing compound. The normal moist curing methods stated herein shall then be used over the bridge deck and all other required concrete surfaces.

805.13 EXPANSION AND FIXED JOINTS AND BEARINGS. All joints shall be constructed in accordance with the details shown on the plans, specifications and the following requirements.

(a) Open Joints: Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

(b) Filled Joints: All joints to be sealed with poured or preformed compression seals shall be formed and constructed similar to open joints. When prefabrication types are specified, the filler shall be in correct position when concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed. Adequate water stops of metal, rubber or plastic shall be carefully placed as shown on the plans.

(c) Joint Seals (Nonreinforced): Nonreinforced seals used for bridges are of 2 general types: liquid poured and preformed. Both types shall effectively prevent water leakage and the intrusion of incompressible materials.

Unless otherwise required, the joints are to be sealed full width, including curbs and sidewalks.

(1) Liquid Poured: The joint seal shall conform to Subsection

1005.02(b). The joints shall be thoroughly cleaned, using whatever equipment is necessary. Before application of the poured joint seal, the joint faces must be sandblasted unless otherwise specified. The joints shall be thoroughly cleaned and dry at the time of installation. The joint seal shall be installed in accordance with the manufacturer's recommendations. Care shall be taken that the material's shelf life is not exceeded and that application is accomplished at 70°F or above. Application shall be done by a machine with a powered mixing device with an accurate method of proportioning and mixing the 2 separate components.

Primers, if required, shall be applied as directed by the manufacturer; however, it shall be applied the same day as the installation and shall be tack free prior to installation of the joint seal.

Joints shall be backed with closed cell polyethylene foam joint fillers to obtain the correct depth of seal. The filler may be cast into the joint or compressed into the joint such that it adheres tightly to the sides of the joint providing a stable backing for the poured joint seal. This backing material must not adhere to the seal material and must be of a character recommended by the seal manufacturer.

(2) **Preformed Elastomeric Compression Joint Seal:** The joint seal and lubricant-adhesive materials shall conform to Subsection 1005.03. The joints shall be thoroughly cleaned and free of loose rust using whatever equipment is necessary. Where armored joints are welded for alignment for construction purposes, the weld spots shall be ground smooth prior to seal placement. In all cases the joints shall be smooth faced and thoroughly clean and dry at the time of installation. The joint seal shall be installed in accordance with the manufacturer's recommendations.

The lubricant-adhesive shall be applied just prior to installation and shall be sufficient to completely cover the seal's sidewalls. The installation shall be done in a manner that least disturbs the lubricant-adhesive on the joint walls. Dilution of the lubricant-adhesive will not be allowed.

Stretching of the seal should be minimal. When installation procedures appear to cause stretching, random checks shall be made. The frequency and thoroughness of the checks shall be as directed by the engineer as he deems necessary in accordance with the adequacy of the installation. The maximum allowable stretch of the compression seal is 5 percent. When the maximum stretch limits are exceeded, and the lubricant-adhesive has chemically set, the seal shall be completely removed and cleaned, the joint recleaned and reinstallation made.

One manufacturer's shop splice per 48 foot length will be allowed provided field performance and laboratory tests indicate satisfactory performance. Field splicing shall not be allowed unless specifically noted

on the plans to accommodate severe angles in the seal due to planned alignment.

(d) Steel Reinforced Elastomeric Joint Seals: Steel reinforced elastomeric joint seals and sealants shall conform to Subsection 1005.04 and shall be approved products on the Department's Qualified Products List.

Prior to installation, the contractor shall advise the engineer of his intended method of construction, anchorage system and method of setting system according to temperature.

A recess shall be constructed with adjustable forms set to proper dimensions for the temperature at the time of pouring. Forms shall be released within two hours after pouring concrete. All edges shall be tooled. The maximum misalignment from parallel with the slab surface will be 1/16 inch.

Projections on the sides and bottom of the recess shall be removed. All depressions, voids, honeycombs and air bubbles shall be filled with an approved rapid setting patching material.

All joints shall be installed as shown on the plans and in accordance with the manufacturer's recommendations.

Prior to installation, the concrete or metal surface on which the seal is to be set shall be sandblasted and shall be dry; shall be free from dirt, grease, oil, or other contaminants; shall be level; and shall be sound with no broken or spalled concrete. No joint shall be placed until the engineer has inspected and approved the seat conditions. Immediately prior to installation, all neoprene surfaces to be in contact with sealant shall be buffed or wire brushed to provide a bonding surface, and shall be cleaned with toulene or mineral spirits.

The sealant must be thoroughly mixed before applying and shall be placed for one section at a time. The sealant shall be in a layer at least ¼ inch thick on the bottom of the form-out and extend from the bottom corner of the form-out to 1½ inches past the anchor. The joint must be placed within 30 minutes after the sealant is mixed. The joint shall be positioned over the anchor bolts and nuts securely tightened. All loose or long anchor bolts shall be corrected in a manner approved by the engineer. Prior to filling the space in the bolt wells, the engineer's inspection of the anchor bolts and tightening of the nuts will be required. All joints between units, around connecting bolts, and cavity plugs shall be carefully sealed with sealant in a neat, workmanlike manner.

The finished joint shall present a smooth, neat appearance with no protruding bolts or rough joints. Excess sealant shall be removed before it becomes hard. Upon completion of an entire joint, the contractor shall grind any uneven end butt connections flush. Any openings between butt ends not showing mastic to the top shall be cleaned and filled with mastic.

The ends of the joint at the curb faces shall be caulked with mastic. When the bridge deck is to be waterproofed and surfaced, the installation of the joint shall be completed prior to placement of waterproofing and surfacing.

(e) Premolded Expansion Joint Filler:

(1) Nonextruding and Resilient Types: Nonextruding and resilient types shall conform to Subsection 1005.01.

(2) Asphaltic Types: Asphaltic types shall conform to Subsections 1005.01(a)(1) or 1005.01(a)(3).

(3) Nonasphaltic Types: Nonasphaltic types shall conform to Subsection 1005.01(a)(2) or 1005.01(c).

(f) Steel Joints: The plates, angles or other structural shapes shall be accurately fabricated to conform to the section of the concrete floor. The fabrication and painting shall conform to the specifications covering those items. When specified, the materials shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be designated on the plans at the prescribed temperature and care shall be taken to avoid impairment of the required clearance.

Temporary restraints placed in joints shall be removed as soon as practicable after the casting of adjacent pours where they are able to resist the contraction of the adjacent concrete.

(g) Water Stops: Adequate water stops of metal, rubber or plastic shall be placed as shown on the plans. Where movement at the joint is provided for, the water stops shall be of a type permitting such movement without injury. They shall be spliced, welded or soldered to form continuous watertight joints.

(h) Bearing Devices: Bearing plates, rockers and other expansion devices shall be constructed according to details shown on the plans. The masonry surfaces on which bearings are to be set shall be finished to insure a true and uniform bearing at the grade and elevation shown on the plans. Bronze or copper-alloy plates shall conform to Subsection 1013.07. Structural steel and painting shall conform to the specifications for those items. When specified, the material shall be galvanized in lieu of painting. The rockers or other expansion devices shall be accurately set considering temperature and deflection at the time of erection.

(i) Elastomeric Bridge Bearing Pads: Elastomeric bearing pads shall conform to these specifications and Subsection 1017.14. These bearings may be either plain (consisting of elastomer only) or laminated (consisting

of layers of elastomer interspersed with nonelastic laminates) as shown on the plans. Bearings shall be specified on the plans by hardness (durometer), size and configuration and, in the case of laminated bearings, by the thickness of individual layers of elastomer and the size and position of special connection members, of any, required to be vulcanized with the bearing.

805.14 CONCRETE SURFACE FINISHES. Surface finishes shall be classified as follows:

Class 1.	Ordinary Surface Finish
Class 2.	Rubbed Finish
Class 2A.	Special Surface Finish
Class 4.	Sandblast Finish
Class 6.	Bridge Deck Finish
Class 7.	Sidewalk Finish
Class 8.	Precast-Prestressed Concrete Finish

All concrete shall be given Class 1, Ordinary Surface Finish, in addition to any other type of finish as is specified. If not otherwise specified, the following surfaces shall be given a Class 2, Rubbed Finish: the exposed faces of wing walls, retaining walls, railings and parapets; the outside faces of girders, slabs, brackets, curbs, headwalls, and parapets; but not the tops and bottoms of floor slabs and sidewalks, bottoms of beams and girders, sides of interior beams and girders, backwalls above bridge seat or the underside of copings. Wing walls shall be finished from the top to one foot below the finish slope lines on the exposed face and shall be finished on top and for a depth of one foot below the top on the backfill sides.

Unless otherwise specified, roadway floors shall be given a Class 6, Bridge Deck Finish.

(a) Class 1, Ordinary Surface Finish: Immediately following the removal of forms all fins and irregular projections shall be removed from all surfaces except from those which are not to be permanently exposed to view after construction or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycombed spots, broken corners or edges and other defects shall be thoroughly cleaned and, after having been kept saturated with water, shall be pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished.

Mortar used in pointing shall be not more than one hour old. The concrete shall then be rubbed or cured as specified under Subsection 805.12. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

The resulting surfaces shall be true and uniform. All surfaces which cannot be satisfactorily repaired shall be "rubbed" as specified for Class 2, Rubbed Finish.

Exposed surfaces not protected by forms shall be struck off with a straightedge and finished with a wood float to a true and even surface. The use of additional mortar to provide a grout finish will not be permitted.

(b) Class 2, Rubbed Finish: After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing of rod holes and defects to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions used in the concrete being finished.

Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed, the surface shall be left free from all unsound patches, paste, powder and objectionable marks.

(c) Class 2A, Special Surface Finish: The Class 2A, Special Surface Finish, will be allowed as a contractor's alternate in lieu of the Class 2, Rubbed Finish. When the Special Surface Finish is used it shall be used throughout the project in lieu of the Class 2, Rubbed Finish.

The Special Surface Finish shall not relieve the contractor of full responsibility for performing the Class 1, Ordinary Surface Finish as required immediately following the removal of forms.

Application of the Special Surface Finish shall not be started until all other work which might damage or mar the surface finish is complete nor until finishing operations can be carried out continuously from beginning to completion on any one bridge.

The mixture used shall be one of the approved mixtures described in Subsection 1011.04. The same materials and methods shall be used for all surfaces on the project that are given this Special Surface Finish.

(d) Class 4, Sandblasted Finish: After 28 curing days, the concrete surface shall be sandblasted with hard, sharp sand to produce an even fine-grained surface in which the mortar has been cut away, leaving the aggregate exposed.

(e) Class 6, Bridge Deck Finish:

(1) Striking Off: After the concrete is placed and consolidated according to Subsection 805.04, bridge floors or top slabs of structures serving as finished pavements shall be finished either by hand methods or approved mechanical machines unless otherwise noted on the plans. Continuous span units shall be struck off with approved mechanical equipment.

When the hand method is used, the bridge floors or slabs shall be struck-off with a screed which is parallel to the centerline of the roadway, resting on bulkheads or screed strips cut or set to the required cross section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and the cutting edge shall be adjusted to conform to the profile of the roadway. Screeds shall be of sufficient length to finish the full length of spans 50 feet or less in length. These screeds shall be mechanically operated for finishing spans over 50 feet in length and may not be used to strike off spans in excess of 75 feet without permission of the engineer.

Spans over 50 feet in length and continuous spans shall be placed with lengths of pours as shown on the plans. Screed strips or headers shall be accurately set to the specified grades, checked, and adjusted as necessary prior to the final screeding operation. The screed shall be worked back and forth over the surface until the proper profile and cross section is obtained.

When mechanical finishing machines are used, they shall be approved power driven machines, traveling on rails adjusted to conform to the profile or cross section of the roadway. The machines shall be equipped with transverse or longitudinal screeds and shall be adjusted to conform to the profile or the required cross section of the roadway. Consolidation by a vibratory action of the finishing machine will not be permitted. The screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of the bridge floor as many times as it is required to obtain the required profile and cross section, or as directed. A light excess of concrete shall be kept in front of the cutting edge of the screed at all times. This excess of concrete shall be carried all the way to the edge of the pour or form and shall not be worked into the slab but shall be wasted.

Excess water, laitance or foreign materials brought to the surface during the course of the finishing operations shall not be reworked into the slab, but shall be removed immediately.

In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(2) **Straightedging:** After finishing as described above, the entire surface shall be checked by the contractor with an approved 10-foot metal straightedge operated parallel to the centerline of the bridge and shall show no deviation in excess of ⅛ inch from the testing edge of the straightedge. Deviations in excess of this requirement shall be corrected before the concrete sets. The checking operation shall progress by overlapping the straightedge at least ½ the length of the preceding pass. Major deviations shall be corrected by the strike-off with the straightedge being used to correct minor deviations and as a checking device.

(3) **Final Finishing:** After surface irregularities have been removed and a satisfactory smooth surfacing has been obtained, the concrete shall be given a uniformly textured final surface finish by use of a metal tine texturing device. The tines shall be approximately 0.025 x 0.126 inch steel flat wire, 4 to 5 inches in length spaced on ½ inch centers. The grooves produced in the concrete shall be 3/16 inch in depth with a minimum depth of ⅛ inch. The grooves shall be transverse to the centerline of the roadway. A mechanical or a manual operation may be used to propel the metal tines provided the required texture is obtained.

Depth of final finish will be checked in accordance with DOTD Designation: TR 229. Texturing equipment other than that specified herein may be approved provided it produces an equivalent texture.

During final surface finishing operations, all areas that are improperly finished shall be refloated and refinished as required.

(f) Class 7, Sidewalk Finish: After the concrete has been deposited in place, it shall be consolidated and the surface shall be struck off by means of a strike board and floated with a wooden or cork float. An edging tool shall be used on all edges and at all expansion joints. The surface shall not vary more than ⅛ inch under a 10-foot straightedge. The surface shall have a granular or matte texture which will not be slick when wet.

(g) Class 8, Precast-Prestressed Concrete Finish: All concrete for precast-prestressed bridge members shall be given Class 1, Ordinary Surface Finish at the plant as soon as possible after casting and before delivery. It is recognized that it is not feasible to eliminate entirely the formation of small cavities due to trapped air in the concrete surfaces next to steel forms and the repair of a reasonable number of these cavities will not be required. However, the manufacturer of precast members will be required to adopt measures to reduce the number and size of trapped air cavities to a reasonable minimum and an excessive number of these cavities will be cause for rejection of the precast member. In all other respects, the concrete finish for precast-prestressed bridge members shall be given Class 1, Ordinary Surface Finish by the manufacturer.

After completion of the structure, all construction damage shall be repaired so as to restore the Class 1, Ordinary Surface Finish. The exposed

surfaces of precast-prestressed concrete piles shall be cleaned to produce a uniform color. The cleaning shall not be done in a manner to destroy the somewhat glazed surface of the concrete resulting from the use of metal forms.

During the pouring of the decks, the contractor shall keep girders clean by washing and shall remove any materials that adhere to the surface and mar the finish of the girders.

805.15 PRESTRESSED CONCRETE.

(a) Description: The construction of prestressed concrete members shall conform to the preceding subsections in this section except those requirements which are modified or supplemented by the provisions which follow.

(b) Supervision and Inspection: Unless otherwise permitted, the contractor or fabricator shall provide a technician skilled in the use of the system of prestressing to be used who shall supervise the work and provide assistance to the engineer as may be required.

Shop drawings as required under Subsection 801.03 shall be approved and in the possession of the plant inspector at least two days prior to beginning fabrication. Free access to all parts of the contractor's or manufacturer's plant engaged in the fabrication of prestressed concrete bridge members shall be afforded the engineer at all times while prestressed members are being fabricated. All areas where inspection is required shall be kept clean and free of debris so as to provide safe access to the work.

Inspection of prestressed concrete bridge members shall be in accordance with the current Interim Manual for the inspection of prestressed concrete bridge members of the AASHTO with latest amendments and as modified by the Department's addendum modifying tolerance requirements. Upon abandonment of the Interim Manual and adoption of a permanent Manual, inspection shall be in accordance with the current adopted Manual for Inspection of prestressed concrete bridge members of the AASHTO with latest amendments. All required finishing repairs and curing shall be accomplished immediately after casting and before placing the members into (permanent) storage.

The contractor or fabricator shall furnish the engineer adequate office space to perform necessary work with a minimum of 140 square feet of floor space containing desk, chair, file cabinet with lock, telephone, electric lights, power outlets, shelves and tables, all in the quantity as required by the engineer. The office shall also be provided with adequate heating, ventilation, and air conditioning, and convenient sanitary facilities, and it shall be in good repair and free of excessive noise.

The contractor or fabricator shall furnish a concrete cylinder breaking machine of minimum 250,000 lbs. capacity conforming to ASTM Desig-

nation: C 39 for use by the inspector. Suitable facilities for the use of this machine shall also be furnished. These testing machines shall be calibrated by an approved laboratory at the manufacturer's expense prior to initial use and at 1 year intervals thereafter. If during the use of the machine it appears to be giving erratic results, recalibration will be required at that time.

(c) Equipment and Stressing Requirements — General: The contractor or fabricator shall provide all equipment necessary for the construction and the prestressing. Prestressing shall be done with approved equipment. If hydraulic jacks are used, they shall be equipped with accurate reading pressure gages.

In all methods of tensioning, the stress induced in the tendons shall be measured both by jacking gages and by elongations of the reinforcement, and the results shall check within the specified limits. Means shall be provided for measuring the elongation of reinforcement to the nearest 1/32 inch.

Prior to use in manufacture of prestressed members under these specifications, all jacks to be used, together with their gages, shall be calibrated by an approved laboratory. For jacks up to 200 tons capacity and which can be placed within the available testing machine, the calibration will be performed without charge by the Department's Materials Laboratory, provided the jacks are delivered there by the contractor. For larger jacks, calibration by proving ring or other acceptable method, performed by an established testing company at the expense of the contractor, will be required. During progress of the work, if any jack or gage appears to be giving erratic results or if gage pressure and elongations indicate materially differing stresses, recalibration will be required.

It is anticipated that there may be a possible difference in indicated stress between jack pressure and elongation of about 5 percent. In such event, the error shall be so placed that the discrepancy shall be on the side of a slight overstress. In the event of an apparent discrepancy between gage pressure and elongation of as much as 10 percent, the entire operation shall be carefully checked and the source of error determined before proceeding further.

The amount of stress to be given each stressing element shall be as shown on the plans.

Pretensioning of all tendons will be in prescribed stages to allow for stress equalization throughout the tendon.

(d) Concrete: Concrete for all prestressed members shall be Class P or P(M) as specified.

The design of the concrete mix within the limits of these specifications shall be the sole responsibility of the contractor subject to approval by the engineer of the mix and materials, but such approval shall not relieve the

contractor of the responsibility for the product furnished.

In all other respects the concrete shall be controlled, mixed and handled as specified in Sections 805 and 901.

Concrete shall not be deposited in the forms until the engineer has inspected the placing of the reinforcement, conduits, anchorages and prestressing tendons and has given his approval.

The concrete shall be vibrated internally or externally or both, as ordered by the engineer. The vibrating shall be done with care in such manner as to avoid displacement of reinforcing, conduits or tendons.

Tops of prestressed beams shall be rough floated. At approximately the time of initial set, the entire top of beams shall be scrubbed transversely with a coarse wire brush to remove all laitance and to produce a roughened surface for future bonding.

(e) Forms and Forming for Bridge Girders: The prestressed members shall be cast in steel forms. Bolted form joints shall be so spaced that no exterior girder shall have more than 2 bolted joints or seams. All bolted joints or seams shall be thoroughly sealed to minimize bleeding.

Prior to the final preparation of forms for the placement of concrete, the forms shall be thoroughly cleaned and uniformly coated with a form-release agent listed on the Department's Qualified Products List. The outside surfaces of forms shall be maintained reasonably clean and free from concrete build-up.

Forms that have become heated shall be cooled by spraying with water immediately prior to pouring concrete in each section.

Girder ends shall be coated with a protective coating conforming to Subsection 1008.11(a) to protect strand ends.

Prestressed members shall be finished in accordance with Subsection 805.14(g).

(f) Curing: To establish the adequacy of the curing methods used and to determine whether the concrete has attained the required minimum compressive strength for the various operations, 7 test cylinders will be made and cured under the same conditions as the members. Two cylinders will be broken at the end of 28 days. The remaining 5 cylinders will be broken at any time requested by the contractor. However, in the event all 5 cylinders are broken at the request of the contractor and the concrete has not yet attained the required strength, the members involved will be held at the plant until the 28-day cylinders are broken. If the concrete has not yet attained the required strength, all members involved will be rejected. Curing methods other than steam curing shall be according to Subsection 805.12. The hot weather concrete limitations as stipulated in Subsection 901.13(b) shall not be applicable for steam curing; however, precautions such as cooling forms shall be required.

Steam Curing: Steam curing, when selected by the contractor, shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam may be from 2 to 4 hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam may be increased from 4 to 6 hours. The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam the ambient air temperature shall increase at a rate not to exceed 40°F per hour until a uniform temperature not exceeding 160°F is reach. This temperature shall be held until the concrete has reached the required release strength. At this time the steam curing may be discontinued. The concrete shall remain covered for two hours minimum after steam curing has ceased at which time detensioning shall be accomplished. Recording thermometers showing the time-temperature relationship shall be furnished at the rate of 1 for each 200 feet of bed.

(g) Transportation and Storage: Precast girders shall be transported in an upright position, and points of support and directions of the reactions with respect to the girder shall be approximately the same during transportation and storage as when the girder is in its final position.

Care shall be taken during storage, hoisting and handling of precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the contractor at his expense.

All members may be handled immediately after completion of stressing. In the event that stressing is not done in a continuous operation, members shall not be handled before they are sufficiently stressed, as determined by the engineer, to sustain all forces and bending moments due to handling.

All prestressed members shall be held at the plant until the concrete has attained the specified 28-day compressive strength.

Prestressed members may be installed at any time after completion of stressing and grouting, providing the concrete has attained the specified minimum 28-day compressive strength, except for the driving of prestressed piling.

Prestressed concrete piling shall be held at the plant until one of the following criteria is met:

(1) 10 days after the specified minimum 28-day compressive strength is attained or

(2) 14 days after casting, provided the specified minimum 28-day compressive strength has been attained.

(h) Pretensioning Method: The prestressing elements shall be accurately held in position and stressed by jacks. A record will be kept of the

jacking force and tendon elongation produced. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to the concrete nor shall end anchors be released until the concrete has attained the specified release strength as shown by standard cylinders made and cured identically with members. The elements shall be cut or released in such an order that lateral eccentricity of prestress will be a minimum in accordance with the approved shop drawings.

All strands to be prestressed in a group shall be brought to a uniform initial tension prior to being given their full pretensioning. This uniform initial tension of approximately 1,000 to 2,000 pounds shall be measured by a dynamometer or other approved means so that its amount can be used as a check against elongation computed and measured.

After this initial tensioning, the group shall be stressed until the required elongation and jacking pressure are attained and confirmed within the limits hereinabove specified.

With the cables stressed in accordance with the plan requirements and the foregoing specifications and with all other reinforcing in place, the concrete shall be cast to the desired lengths. Strands shall not be spliced within the casting length of any girder.

(i) **Posttensioning Method:** The tensioning process shall be conducted so that the tension being applied to the tendon and its elongation may be measured at all times. The friction loss shall be estimated as provided below. A record shall be kept of gage pressures and elongations at all times and submitted to the engineer for his approval. Loads shall not be applied to the concrete until it has attained the compressive strength as specified in (h) for the pretensioning method.

Posttensioning tendons of straight members may be tensioned from one end. Posttensioning tendons of curved members shall be stressed by simultaneous jacking from both ends of the stressing element unless otherwise specified.

Friction Losses: Friction losses in posttensioned steel shall be based on experimentally determined wobble and curvature coefficients, and shall be verified during stressing operations. The values of coefficients assumed for design, and the acceptable ranges of jacking forces and steel elongations shall be as shown on the plans. These friction losses shall be calculated as follows:

$$T_O = T_X \times e^{(KL + \mu\alpha)}$$

When $(KL + \mu\alpha)$ is not greater than 0.3, the following equation may be used:

$$T_O = T_X \times (1 + KL + \mu\alpha)$$

in which

T_o = Steel stress at jacking end.

T_x = Steel stress at any point x.

e = Base of Naperian logarithms.

K = Friction wobble coefficient per foot of prestressing steel.

L = Length of prestressing steel element from jacking end to point x, in feet.

μ = Friction curvature coefficient.

α = Total angular change of prestressing steel element in radians from jack to point x.

The following values for K and μ may be used when experimental data for the materials used are not available:

Type of Steel	Type of Duct	K	μ
Wire or ungalvanized strand	Bright Metal Sheathing	0.0020	0.30
	Galvanized Metal Sheathing	0.0015	0.25
	Greased or asphalt-coated and wrapped	0.0020	0.30
	Galvanized rigid	0.0002	0.25
High-strength bars	Bright Metal Sheathing	0.0003	0.20
	Galvanized Metal Sheathing	0.0002	0.15

Friction losses occur prior to anchoring but should be estimated for design and checked during stressing operations. Rigid ducts shall have sufficient strength to maintain their correct alignment without visible wobble during placement of concrete. Rigid ducts may be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required.

(j) Grouting of Bonded Steel: Posttensioning prestressed members shall be of the bonded type in which the tensioned steel is installed in holes or flexible metal ducts cast in the concrete and bonded to the surrounding concrete by filling the tubes or ducts with grout. The grout shall be an approved portland cement grout mixture with a shrink reducing additive containing no ingredients that are corrosive to steel.

All prestressing reinforcement to be bonded shall be free of dirt, loose rust, grease or other deleterious substances. Before grouting, the ducts shall be

free of water, dirt or any other foreign substances. The ducts shall be blown out with compressed air until no water comes through the duct. For long members with draped strands, an open tap at the low point of the duct may be necessary. Grout cubes shall be molded, and cured with the member and shall attain a compressive strength of at least 3,000 psi prior to the transfer of bond stress or end anchor release. Preparation and testing of the grout cubes shall be in accordance to ASTM Designation: C 109.

The grout shall be fluid (consistency of thick paint) but proportioned so that free water will not separate out of the mix. Unpolished aluminum powder may be added in an amount of one to two teaspoons per sack of cement. Commercial plasticizers used in accordance with the manufacturer's recommendations may be used provided they contain no ingredients that are corrosive to steel. Pressure used in grouting shall be that recommended for the system being used.

(k) Prestressing Reinforcement: Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand or high-tensile-strength alloy bars as specified. Prestressing reinforcement shall conform to Section 1009.

(l) Sampling and Testing Prestressing Reinforcement and Anchorages: Sampling and testing of prestressing reinforcement and anchorages shall be performed in accordance with Section 1009.

Ends of pretensioned strands not to be encased in end diaphragms shall be cut off flush with ends of beam and shall be coated with a suitable asphaltic material.

Should the contractor desire to substitute a different size strand than specified or to substitute ASTM Designation: A 416 Grade 270 strand for ASTM Designation: A 416 Grade 250 strand, he shall submit complete details to the Bridge Design Engineer for review and approval to show that the design he proposes to use is essentially the same as the design plans and as described in these specifications. The design submitted shall correspond in total prestressing force and location of prestressing force in all essential requirements to the design drawings.

805.16 PLACING ANCHOR BOLTS. All necessary anchor bolts in piers, bents, abutments or pedestals shall be set carefully in portland cement mortar at the location and in the manner described herein.

The locations of anchor bolts to be built into the concrete shall be verified by the contractor prior to setting. In this case great care shall be exercised to insure the proper setting of the bolts and any inaccuracies detrimental to the structure shall be corrected by approved means.

The anchor bolts shall be set in preformed holes having a minimum diameter of 3 inches to allow for adjustment and sufficient in depth to admit the anchor bolt. The holes may be formed by the insertion in fresh concrete of

oiled wooden plugs or sheet metal sleeves or other approved devices which are subsequently withdrawn after the concrete has partially set. All such holes shall be adequately protected against the formation of ice while open. When erecting the members, the contractor shall first set the members and shoes in place; then the preformed holes shall be filled sufficiently with grout so that when the anchor bolts are placed to the required depth, the grout will completely fill the holes.

If the contractor elects to set anchor bolts either at initial casting or by drilling, he will be required to verify the centerline to centerline spacing between the anchor bolt holes of each fabricated member before setting the anchor bolts. If bolt holes are drilled, the diameter of the drilled holes shall not be less than ½ inch larger than the diameter of the bolts.

805.17 METHOD OF MEASUREMENT.

(a) General: The quantities of structural concrete, precast-prestressed girders and expansion joint seal for payment will be the design quantities as specified on the plans and adjustments thereto. The design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are made.

(b) Structural Concrete: The design volumes of structural concrete are computed from the neat dimensions shown on the plans with the following modifications. Deductions are made for the volumes occupied by fillets, scorings and chamfers with cross-sectional areas over 1½ square inches, expansion joints, and embedded structural steel and piling. Volumes deducted for embedded piling are based on 12-inch butt diameter timber piling and nominal butt dimensions for other types of piling. No deductions are made for volumes occupied by fillets, scorings and chamfers with cross-sectional areas not more than 1½ square inches, reinforcing steel, water piping, electrical conduit, weep holes, drain piping and armored joints.

(c) Precast-Prestressed Concrete Girders: The design quantities of precast-prestressed concrete girders are based on the out-to-out lengths shown on the plans.

(d) Expansion Joint Seal: The design quantities of expansion joint seal are based on the design lengths shown on the plans.

805.18 BASIS OF PAYMENT.

(a) Structural Concrete: The accepted quantities of structural concrete will be paid for at the contract unit price per cubic yard, adjusted in accordance with the following provisions.

Classes A, A(M), AA, AA(M), D and S concrete will be accepted on a lot basis. A lot will be considered an identifiable pour not to exceed 200 cubic yards of concrete. A pour in the range of 200 to 400 cubic yards will be divided into 2 lots as equal in size as possible while maintaining identifi-

ability. A pour exceeding 400 cubic yards will be represented by 3 lots.

Two random batches will be sampled for each lot, and 3 cylinders molded from each batch. The 6 specimens per lot will be tested for compressive strength in 28 to 31 days.

In the event of sudden cessation of operation, a minimum of 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be made in accordance with Schedule A of Subsection 901.14.

Concrete that is classified as minor structure concrete will be accepted under these specifications and in accordance with Schedule B of Subsection 902.03 and adjustments for payment will be made accordingly.

Unless otherwise provided in the contract, formwork, falsework, cofferdams, bracing, pumping, expansion joint fillers, steel punchings in counterweight concrete and excavation and backfill will be considered as incidental to the work.

(b) Precast-Prestressed Girders: The accepted quantities of precast-prestressed girders will be paid for at the contract unit price per linear foot, which includes all reinforcing steel, masonry, anchor plates, plain or laminated elastomeric bearings, metal or other bearing plates and assemblies or other appurtenances indicated or necessary in the fabrication, handling and erection of the girders.

Tie rods, nuts and washers will be considered as miscellaneous steel and paid for as provided in Section 807.

(c) Expansion Joint Seal: The accepted quantities of expansion joint seal will be paid for at the contract unit price per linear foot.

Payment will be made under:

Item No.	Pay Item	Pay Unit
805(1)	Class A Concrete	Cubic Yard
805(2)	Class A(M) Concrete	Cubic Yard
805(3)	Class AA Concrete	Cubic Yard
805(4)	Class AA(M) Concrete	Cubic Yard
805(5)	Class D Concrete	Cubic Yard
805(6)	Class R Concrete	Cubic Yard
805(7)	Class S Concrete	Cubic Yard
805(8)	Precast-Prestressed Concrete Girders (Type)	Linear Foot
805(9)	Expansion Joint Seal	Linear Foot
805(10)	Steel Reinforced Elastomeric Expansion Joint Seal (Size)	Linear Foot

Section 806

Reinforcement

806.01 DESCRIPTION. This work consists of furnishing and placing reinforcing steel in accordance with the specifications and in conformity with the plans.

806.02 MATERIALS. All materials shall conform to Section 1009.

806.03 STEEL LISTS. Before placing reinforcing steel, 2 copies of a list of all reinforcing steel showing the location, mark number, size and type bend shall be furnished to the engineer at the site for his use in administering the contract. Furnishing such lists to the engineer shall not be construed to mean that the lists will be reviewed for accuracy. The contractor shall be responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

The contractor shall also furnish the engineer 2 copies of a placing plan for all structures where reinforcing steel is involved unless the plans contain sufficient detail for proper placement of reinforcing steel. Placing plans shall show the location, type and spacing of supports.

806.04 FABRICATION. Unless otherwise specified or authorized, bent bar reinforcement shall be cold bent to the shapes shown on the plans in accordance with the following requirements.

(a) Bending: Stirrups and ties shall be bent around a pin having a diameter of at least 4 bar diameters for No. 5 or smaller bars, and at least 5 bar diameters for larger bars. All other bars, except as otherwise specified herein, shall be bent around a pin having a diameter as specified in the following Table I:

TABLE I

PINS FOR BAR BENDS

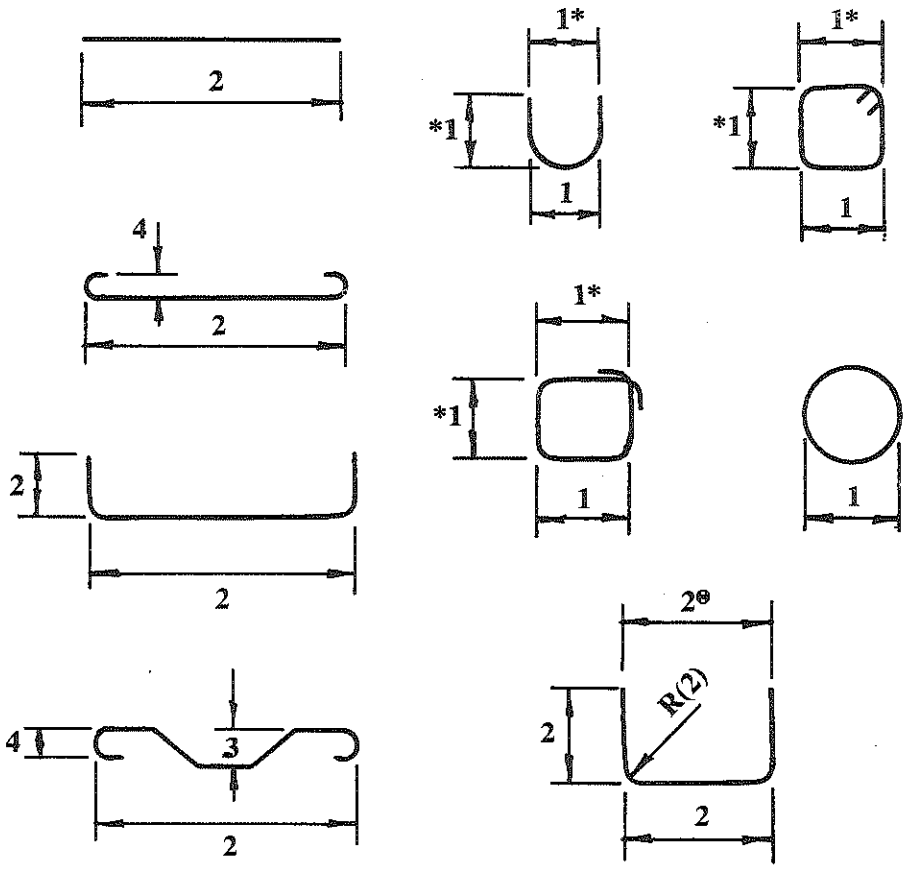
Bar Size	Minimum Pin Diameter
Nos. 3 through 8	6 bar diameters
Nos. 9, 10 and 11	8 bar diameters
Nos. 14 and 18	10 bar diameters

Special fabrication will be required for bending Nos. 14 and 18 bars more than 90 degrees, and all bends of Grade 50 bars.

(b) Tolerances: Bars shall be fabricated in accordance with the tolerances specified in the following Table II. All dimensions given in the table are out-to-out of bars.

TABLE II

FABRICATION TOLERANCES



Tolerance Symbols

1 = Plus or Minus ½″
2 = Plus or Minus 1″
3 = Plus 0″, Minus ½″
4 = Plus 0″, Minus 1″

*Not to differ from opposite parallel dimension by more than ½″.
@Not to differ from opposite parallel dimension by more than 1″.

(c) **Shipping:** Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcement Steel Institute.

806.05 PROTECTION OF MATERIAL. From its delivery to the job until used, reinforcing steel shall be stored above the surface of the ground upon platforms, skids or other supports. It shall be protected at all times from damage.

The various sizes, grades and lengths shall be plainly marked and tagged by the contractor to facilitate inspection and checking.

806.06 PLACING AND FASTENING. All steel reinforcement shall be placed as near as practicable in the position shown on the plans and firmly held during the placing and setting of the concrete. When placed in the work, it shall be free from dirt, loose rust, loose scale, paint, oil, grease or other foreign material. Thin powdery rust and tight rust is not considered detrimental and need not be removed. Bars shall be tied at all intersections with No. 14 or No. 16 gage wire except where spacing is less than one foot in each direction, then alternate intersections shall be tied.

Distance of reinforcement from the forms shall be maintained by means of metal chairs, ties, hangers or other approved supports. Metal chairs in contact with the exterior surface of the concrete shall be hot-dipped galvanized, electroplated with zinc (GS Grade), plastic-coated or stainless steel. Layers of bars shall be separated by approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks will not be permitted. Vertical stirrups shall pass around main tension members and shall be securely attached thereto. The minimum covering, measured from the surface of the concrete to the face of reinforcing bars, shall not be less than 2 inches except as follows: bottom of slab, 1 inch; stirrups and ties in T-Beams, 1½ inches. Additional coverage as shown on the plans shall be provided for reinforcement in bottom of footings or where marine environments, corrosive, abrasive or other severe exposure conditions exist. Reinforcement in any member shall be placed, inspected and approved before placing of concrete begins.

806.07 SPLICING. All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval. Splices shall be staggered as far as possible. Unless shown on the plans, bars shall be lapped 30 bar diameters for Grade 40, or 45 diameters for Grade 60. Construction joints shall not be made within the limits of the lapped bars. In lapped splices the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars and the minimum distance to the surface of the concrete as specified in Subsection 806.06. Welding of reinforcement steel shall be done only if detailed on the plans or if authorized by the engineer in writing. Welding shall

conform to Section 815.

As an alternate to welding, splices may be made by an approved mechanical butt splicing method using a ferrous filler metal with an enclosing steel sleeve or mold. The splice shall develop at least the ultimate stress of reinforcing bars in tension.

(a) Surfaces of reinforcing bars within the sleeve or mold and for 2 inches beyond the end of sleeve or mold shall be cleaned of slag, mill scale, rust and other foreign materials. Cleaning shall be done either by an oxyacetylene torch followed by power wire brushing or by abrasive blasting. Ends of reinforcing bars shall be cut square by carbon arc oxyacetylene cutting or by sawing. Oversized projections on reinforcing bars shall be ground to fit into the sleeve. Flame cutting shall be used only on ends of bars.

(b) Splicing shall be done using a standard, approved, exothermic process whereby molten filler metal, contained by a high strength steel sleeve or mold of larger inside diameter than the bars, is introduced into the annular space between bars and sleeve or mold and also between ends of bars. Upon cooling and hardening of filler metal, the splice shall be capable of transferring the stresses specified from one bar to the other by the mechanical strengths of splice components. The splice shall not depend upon fusion of filler metal with bars nor shall bars be heated to their melting point during the splicing process. Degrees of heat required to effect the splice shall not decrease the structural properties of the bars nor significantly affect the original hardness of bars. Splices shall be made using manufacturer's standard jigs, clamps, ignition devices and other required accessories. The process shall be approved by the engineer. Except as otherwise specified, splicing shall be done in accordance with the manufacturer's recommendations.

(c) As a condition of approval, the contractor shall make 3 test splices in the presence of the engineer of each of the bar sizes he intends to splice. Test splices shall be tension tested, two to destruction and one to yield strength by an approved laboratory; and certified reports of the tests shall be submitted by the contractor at the time of requesting approval.

806.08 SUBSTITUTIONS. Substitutions of different size bars will be permitted with specific authorization of the engineer. If steel is substituted, it shall have cross-sectional and surface areas equivalent to the design areas or larger.

806.09 METHOD OF MEASUREMENT. The quantities of reinforcement for payment will be the design weights as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

Design quantities are based on theoretical weights of nominal size plain round bars as follows:

Bar No.	Weight Lbs./Lin. Ft.	Bar No.	Weight Lbs./Lin. Ft.
3	0.376	9	3.400
4	0.668	10	4.303
5	1.043	11	5.313
6	1.502	14	7.650
7	2.044	18	13.600
8	2.670		

The following will be considered incidental to the work and will not be included in the pay quantities:

(a) Reinforcement furnished for testing purposes.

(b) Additional reinforcement used for laps in splices other than those shown on the plans.

(c) Additional weight of reinforcment used at the contractor's request as substitutions for reinforcement shown in the plans.

(d) Spacers, clips, chairs and other material used in fastening reinforcement in place.

Measurement and payment of structural shapes used as reinforcement will be made in accordance with Section 807.

806.10 BASIS OF PAYMENT. The accepted quantities of reinforcing steel will be paid for at the contract unit price per pound complete in place.

Item No.	Pay Item	Pay Unit
806(1)	Deformed Reinforcing Steel	Pound

Section 807

Structural Metals

807.01 DESCRIPTION. This work consists of furnishing and placing structural metals for structures or portions thereof in accordance with the details shown on the plans and these specifications.

807.02 MATERIALS. All materials shall conform to Section 1013. If the type of structural steel to be used is not specified, steel conforming to ASTM Designation: A 36 shall be used.

807.03 DRAWINGS. Shop drawings and working drawings shall be furnished in accordance with Subsection 801.03.

FABRICATION

807.04 INSPECTION.

(a) Normal Inspection Requirements: The Department will inspect all structural metal.

The engineer will examine the material before it is worked in the shop and will have authority to reject all materials or workmanship not in conformity with the plans and specifications. The contractor or fabricator shall give the Chief Construction and Maintenance Engineer at least 10 days notice before commencing the fabricating of any structural metal. The engineer shall be furnished with 6 complete copies of all mill orders including material orders. Heat number markings will be shown steel die stamped on main material. Round rods and certain bar shapes that are shipped, bundled and tagged with heat number from the mill shall have this heat number transferred steel die stamped to each piece as it arrives at the fabrication plant in the presence of our inspector when these pieces are main members. Materials for other than main members may be identified by painting heat numbers. Main material used from stock shall show steel die stamped heat numbers along with test reports.

In the fabricating shop the transferring of heat numbers shall be steel die stamped for all pieces of main material. In case of doubt as to the grade of metal being used, samples will be taken by the inspector for submittal to the Department's Laboratory for tests to establish the grade of metal in question. A color code system shall be required for all metal to be used in

structures for the Department as specified by the latest AASHTO requirements. This color shall be placed on material upon entering the shop and carried on all pieces to final fabrication.

Identification Color Codes

A 242	Blue	
A 440	Brown	
A 441	Yellow	
A 514	Red	
A 517	Red and Blue	
A 572	Grade 42	Green and White
	Grade 45	Green and Black
	Grade 50	Green and Yellow
	Grade 55	Green and Brown
	Grade 60	Green and Gray
	Grade 65	Green and Blue
A 588	Blue and Yellow	

A 36 may be color coded White

Other metals not covered above nor included in the ASTM Designation: A 6 shall have an individual color code which shall be established and on record for the engineer.

The contractor shall furnish means and assistance for the testing of all materials and workmanship. The engineer shall have free and safe access at all times to any portion of the shops where work is being done under these specifications.

The stamping of any material or finished member shall not preclude their subsequent rejection if found defective. Rejected material shall be promptly replaced.

The contractor or fabricator shall furnish the engineer adequate office space so that he may be able to perform his paperwork in a convenient manner. This office space shall contain desk, chair, telephone and file cabinet with lock. The office shall be located where there is not excessive noise and restricted to clients' inspectors only. Toilet facilities and a place to change clothes shall be convenient.

Metal fabrication work requiring Departmental inspection shall be performed in a plant or shop within the continental United States.

(b) Additional Inspection Requirements:

(1) Mill Inspection: In accordance with usual procedures of the Department, mill inspection of structural metals will not be made; however, certified and notarized copies of mill test reports on chemical and physical tests are required and shall be submitted to the Department's Construction Section for approval and distribution. Seven certified copies of these reports shall be submitted.

(2) **Shop Inspection:** The normal procedure will be for shop inspection of fabrication and assembly of structural steel, castings and other metal items to be performed by engineers of the Construction Section of the Department. Accordingly, a schedule of fabrication for the metal items required for the project including location of the shop and the dates inspection service will be required shall be furnished to the Construction Section. This information shall be provided a minimum of 10 days in advance of commencement of layout work on fabricated material and/or pattern making for castings.

When Consulting Engineers are required to perform inspection services, these requirements will apply when it is so stated in the project specifications.

807.05 TYPE OF FABRICATION. Riveted, bolted and welded construction shall be so noted on the plans. Subject to approval of the engineer, rivets or steel lock-pin and collar fasteners may be substituted for high strength bolts in either shop or field unless otherwise specified on the plans. The contractor shall not mix nuts and bolts from different manufacturers. Each connection shall have the same type of fasteners.

807.06 QUALITY OF WORKMANSHIP. Workmanship and finish shall be equal to the best general practice in modern fabrication shops as interpreted by the engineer.

807.07 HANDLING AND STORING MATERIALS. Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease and other foreign matter and shall be protected as far as practicable from corrosion. It shall be properly drained.

Girders and beams shall be placed upright and stored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection.

807.08 STRAIGHTENING MATERIAL AND CURVING ROLLED BEAMS AND WELDED GIRDERS.

(a) **Straightening Material:** Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Heat straightening of ASTM A514/A517 steel shall be done only under rigidly controlled procedures, each application subject to the approval of the engineer. In no case shall the maximum temperature of the steel exceed 1125°F. Sharp kinks and bends shall be cause for rejection of the material.

(b) **Curving Rolled Beams and Welded Girders:**

(1) **Materials:** Steels that are manufactured to a specified yield point greater than 50,000 psi shall not be heat curved.

(2) Type of Heating: Beams and girders may be curved by either continuous or V-type heating as approved by the engineer. For the continuous method, a strip along the edge of the top and bottom flange shall be heated simultaneously; the strip shall be of sufficient width and temperature to obtain the required curvature. For the V-type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange; the spacing and temperature shall be as required to obtain the required curvature, and heating shall progress along the top and bottom flange at approximately the same rate.

For the V-type heating, the apex of the truncated triangular area applied to the inside flange surface shall terminate just before the juncture of the web and the flange is reached. To avoid unnecessary web distortion, special care shall be taken when heating the inside flange surfaces (the surfaces that intersect the web) so that heat is not applied directly to the web. When the radius of curvature is 1,000 feet or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web. When the radius of curvature is less than 1,000 feet, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to ⅛ of the flange or 3 inches, whichever is less. The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 10 inches. Variations in the patterns prescribed above may be made with the approval of the engineer.

For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is only mandatory when the flange thickness is 1¼ inches or greater, in which case the two surfaces shall be heated concurrently. The maximum temperature shall be as prescribed below.

(3) Temperature: The heat-curving operation shall be conducted in such a manner that the temperature of the steel does not exceed 1150°F as measured by temperature indicating crayons or other suitable means. The girder shall not be artifically cooled until after naturally cooling to 600°F; the method of artificial cooling is subject to the approval of the engineer.

(4) Position for Heating: The girder may be heat-curved with the web in either a vertical or a horizontal position. When curved in the vertical position, the girder must be braced or supported in such a manner that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn.

When curved in the horizontal position, the girder must be supported

near its ends and at intermediate points, if required to obtain a uniform curvature; the bending stress in the flanges due to the dead weight of the girder must not exceed the usual allowable design stress. When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within 2 inches of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

(5) **Sequence of Operations:** The girder shall be heat-curved in the fabrication shop before it is painted. The heat curving operation may be conducted either before or after all the required welding of transverse intermediate stiffeners is completed. However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat curving. If longitudinal stiffeners are required, they shall be heat-curved or oxygen-cut separately and then welded to the curved girder. When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 2½ inches and the radius of curvature is greater than 1,000 feet. For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached; cover plates must be either heat curved or oxygen-cut separately and then welded to the curved beam.

(6) **Camber:** Girders shall be cambered before heat-curving. For plate girders, the web shall be cut to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat-curving. The heat-curving process may tend to change the vertical camber present before heating. This effect shall be most pronounced when the top and bottom flanges are of unequal widths on a given transverse cross section. However, subject to the approval of the engineer, moderate deviations from specified camber may be corrected by a carefully supervised application of heat.

(7) **Measurement of Curvature and Camber:** Horizontal curvature and vertical camber shall not be measured for final acceptance before all welding and heating operations are completed and the flanges have cooled to a uniform temperature. Horizontal curvature shall be checked with the girder in the vertical position by measuring offsets from a stringline or wire attached to both flanges or by using other suitable means; camber shall be checked by adequate means.

807.09 FINISH. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately and shall be ground to a neat finish.

807.10 RIVET AND BOLT HOLES.

(a) Holes for Rivets and High Strength Bolts: All holes for rivets or bolts shall be either punched or drilled. Material forming parts of a mem-

ber composed of not more than 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the rivets or bolts whenever the thickness of the metal is not greater than ¾ inch for structural carbon steel or ⅝ inch for alloy steel.

When there are more than 5 thicknesses or when any of the main material is thicker than ¾ inch in structural carbon steel or ⅝ inch in alloy steel or when required under Subsection 807.13, all the holes shall either be drilled full size or subdrilled.

When required under Subsection 807.13, all holes shall be either subpunched or subdrilled (subdrilled if thickness limitation governs) 3/16 inch smaller and, after assembling, reamed 1/16 inch larger or drilled full size to 1/16 inch larger than the nominal diameter of the rivets or bolts.

When permitted by the plans, enlarged or slotted holes are allowed with high strength bolts.

(b) Holes for Ribbed Bolts, Turned Bolts or Other Approved Bearing Type Bolts: All holes for ribbed bolts, turned bolts or other approved bearing type bolts shall be subpunched or subdrilled 3/16 inch smaller than the nominal diameter of the bolt and reamed assembled or to a steel template or, after assembling, drilled from the solid at the option of the fabricator. In any case the finished holes shall provide a driving fit as specified in the plans or project specifications.

807.11 PUNCHED HOLES. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. If any holes must be enlarged to admit the rivets or bolts they shall be reamed. Holes must be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection; any repair shall be witnessed by the engineer.

807.12 REAMED OR DRILLED HOLES. Reamed holes shall be cylindrical, perpendicular to the member and not more than 1/16 inch larger than the nominal diameter of the rivets or bolts. Where practicable, reamers and drills shall be directed by mechanical means. Drilled holes shall be 1/16 inch larger than the nominal diameter of the rivet or bolt. All burrs shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist reamers or twist drills. If required, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

807.13 PREPARATION OF FIELD CONNECTIONS.

(a) Subpunching and Reaming of Field Connections: Unless otherwise specified in the plans or project specifications, holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames

shall be subpunched (or subdrilled if subdrilling is required) according to Subsection 807.10 and subsequently reamed while assembled or to a steel template, as required by Subsection 807.17. All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled. Reaming or drilling full size of field connection holes through a steel template shall be done after the template has been located with utmost care as to position and angle and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match-marking.

For any connection, in lieu of subpunching and reaming or subdrilling and reaming, the fabricator may, at his option, drill holes full size with all thicknesses of material assembled in proper position.

If additional subpunching and reaming is required, it shall be specified in the plans or project specifications.

(b) Numerically-Controlled Drilled Field Connections:

(1) General: Alternately, for any connection or splice designated in Subsection 807.13(a), in lieu of subsized holes and reaming while assembled, or drilling holes full-size while assembled, the contractor shall have the option to drill bolt holes full-size in unassembled pieces and/or connections including templates for use with matching subsized and reamed holes by means of suitable numerically-controlled drilling equipment subject to the following specific provisions.

If numerically-controlled drilling equipment is used, the engineer, unless otherwise specified, may require the contractor, by means of check assemblies to demonstrate that this drilling procedure consistently produces holes and connections meeting the requirements of Subsection 807.15 and 807.17.

The contractor shall submit to the engineer for approval a detailed outline of the procedures that he proposes to follow in accomplishing the work from initial drilling through check assembly, if required, to include the specific members of the structure that may be numerically-controlled drilled, the sizes of the holes, the location of common index and other reference points, composition of check assemblies and all other pertinent information.

(2) Holes: Holes drilled by numerically-controlled drilling equipment shall be drilled to appropriate size either through individual pieces, or any combination of pieces held tightly together.

807.14 ACCURACY OF PUNCHED AND DRILLED HOLES. All holes punched full size, subpunched or subdrilled shall be so accurately

punched that after assembling (before any reaming is done) a cylindrical pin ⅛ inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If the requirement is not fulfilled the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch smaller in diameter than the nominal size of the punched holes, this will be cause for rejection.

807.15 ACCURACY OF REAMED AND DRILLED HOLES. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thicknesses of metal.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. The centerlines shall be used in locating accurately the template from the milled or scribed ends of the members.

807.16 FITTING FOR RIVETING AND BOLTING. Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-sized punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than 1/16 inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct position and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts, in so far as practicable, to prevent damage in shipment and handling.

807.17 SHOP ASSEMBLING. The field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing, and then shall have their sub-size holes reamed to specified size while the connections are assembled. Assembly shall be Full Truss or Girder Assembly unless Progressive Truss or Girder Assembly, Full Chord Assembly, Progressive Chord Assembly, or Special Complete Structure Assembly is specified in the plans or project specifications.

Check Assemblies with Numerically-Controlled Drilled Field

Connections shall be in accordance with the provisions of Heading (g) of this subsection.

Each assembly, including camber, alignment, accuracy of holes and fit of milled joints, shall be approved by the engineer before a numerically-controlled drilled check assembly is dismantled.

A camber diagram shall be furnished the engineer by the fabricator showing the camber at each panel point of each truss, arch rib, continuous beam line, plate girder or rigid frame.

(a) Full Truss or Girder Assembly: Full Truss or Girder Assembly consists of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder or rigid frame at one time.

(b) Progressive Truss or Girder Assembly: Progressive Truss or Girder Assembly consists of assembling initially for each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at least three contiguous shop sections or all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices) and not less than 150 feet in the case of structures longer than 150 feet. At least one shop section or panel or as many panels as are associated with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end, so that the assembled portion of the structure is never less than that specified above.

(c) Full Chord Assembly: Full Chord Assembly consists of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then reaming their field connection holes while the members are assembled and reaming the web member connections to steel templates set at geometric (not cambered) angular relation to the chord lines.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

(d) Progressive Chord Assembly: Progressive Chord Assembly consists of assembling contiguous chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.

(e) Special Girder Assembly: This procedure does not apply to continuous girders, but will be required for rolled beams or plate girders that are part of a simple supported span with a horizontal curve, skewed or superelevated, or any combination thereof.

Special girder assembly consists of assembling rolled beams or plate

girders in pairs with all adjacent girders, including floor system, lateral bracing, cross frames, etc. These pairs of beams or girders shall be assembled on blocking with the proper camber and their relative elevation, as to ensure proper fitting of all parts during field erection in accordance with any of the previously described methods.

(f) Special Complete Structure Assembly: Special Complete Structure Assembly consists of assembling the entire structure, including the floor system. This procedure is ordinarily needed only for complicated structures such as those having curved girders, or extreme skew in combination with severe grade or camber.

(g) Check Assemblies with Numerically-Controlled Drilled Field Connections: A check assembly will be required for each major structural type of each project, unless otherwise designated in the plans or project specifications and shall consist of at least three contiguous shop sections or, in a truss, all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Check assemblies should be based on the proposed order of erection joints in bearings, special complex points, and similar considerations. Such special points could be the portals of skewed trusses, etc.

Use of either geometric angles (giving theoretically zero secondary stresses under dead-load conditions after erection) or cambered angles (giving theoretically zero secondary stresses under no-load conditions) shall be as designated in the plans or project specifications.

The check assemblies shall preferably be the first such sections of each major structural type to be fabricated.

No match-marking and no shop assemblies other than the check assemblies will be required.

The shop detail drawings shall indicate clearly subpunched holes which are to be reamed assembled or reamed to a template in the shop and all groups of holes which are to be drilled full size with numerically-controlled drills.

If the check assembly fails to demonstrate that the required accuracy is being obtained, further check assemblies may be required by the engineer for which there shall be no additional cost to the Department.

807.18 DRIFTING OF HOLES. The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the bolts or rivets, they shall be reamed.

807.19 MATCH-MARKING. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked

with steel stencils and a diagram showing such marks shall be furnished to the engineer.

807.20 RIVETS. The size of rivets specified on the plans shall be the size before heating. Rivet heads shall be of standard shape unless otherwise specified, and of uniform size for the same diameter of rivet. They shall be full, neatly made, concentric with the rivet holes, and in full contact with the surfaces of the member. Sufficient field rivets shall be furnished to rivet the entire structure with an ample surplus to replace all rivets burned, lost or cut out.

807.21 BOLTS AND BOLTED CONNECTIONS. The specifications of this subsection do not pertain to the use of high strength bolts. Bolted connections fabricated with high strength bolts shall conform to Subsection 807.22.

(a) General: Bolts shall be unfinished, turned or ribbed bolts conforming to ASTM Designation: A 307, Grade A. Bolted connections shall be used only as indicated in the plans or project specifications. Bolts shall have single self-locking nuts or double nuts unless otherwise specified. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

(b) Unfinished Bolts: Unfinished bolts shall be furnished unless other types are specified.

(c) Turned Bolts: The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

(d) Ribbed Bolts: The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 inch greater than the nominal diameter specified for the bolts.

Ribbed bolts shall be furnished with round heads conforming to ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an oversized bolt used as a replacement.

807.22 CONNECTIONS USING HIGH STRENGTH BOLTS.

(a) General: This specification covers the assembly of structural joints

using ASTM Designation: A 325 or A 490 high strength steel bolts tightened to a high tension. The bolts are used in holes 1/16 inch larger than the nominal bolt size.

Construction shall conform to the specifications for riveted or welded structures of wrought iron, carbon structural steel and high strength steel, except as otherwise provided herein.

(b) Lock-Pin and Collar Fasteners: When specified or approved for use by the engineer, lock-pin and collar fasteners shall conform to Subsection 1013.08(c). The installation of lock-pin and collar fasteners shall be by methods and procedures approved by the engineer.

(c) Bolts, Nuts and Washers: Bolts, nuts and washers shall conform to ASTM Designation: A 325 or A 490, whichever is specified.

(1). Bolt dimensions shall conform to the current requirements for heavy hex structural bolts of ANSI Designation: B 18.2.1.

(2) Nut dimensions shall conform to current requirements for heavy hex nuts of ANSI Designation: B 18.2.2.

Unless otherwise specified, the minimum bolt length shall be determined by adding the appropriate length given in the following table to the grip (total thickness of all connected material, excluding washers):

BOLT LENGTH

Bolt Size (inches)	Length to Add to Grip (inches)
1/2	11/16
5/8	7/8
3/4	1
7/8	1-1/8
1	1-1/4
1-1/8	1-1/2
1-1/4	1-5/8
1-3/8	1-3/4
1-1/2	1-7/8

Add 5/32″ for each hardened flat washer, and add 5/16″ for each beveled washer. The minimum bolt length thus determined shall be increased to the nearest ¼″ to obtain the required bolt length, but in no case shall the bolt have less than 2 threads beyond the nut after final torque.

Circular washers shall be flat and smooth and their nominal dimensions

shall be not less than those given in Table I of this specification with ANSI B 27.2, Type A washer tolerances applied to these nominal dimensions. Beveled washers shall be square or rectangular, taper in thickness and conform to the dimensions given in Table I. Where necessary, washers may be clipped on one side to a point not closer than 7/8 of the bolt diameter from the center of the washer.

TABLE I

WASHER DIMENSIONS[a]

Circular Washer					Square or Rectangular Beveled Washers for American Standard Beams and Channels		
Bolt Size D	Nominal Outside Diameter[b]	Nominal Diameter of Hole	Thickness Min.	Thickness Max.	Minimum side Dimension	Mean Thickness	Slope or taper in Thickness
1/2	1-1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1-5/16	21/32	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178	.28	. . . .	. . . .	. . . .
2	3-3/4	2-1/8	.178[c]	.28[c]	. . . .	. . . .	. . . .
Over 2 to 4 incl.	2D-1/2	D+1/8	.24[d]	.34[d]	. . . .	. . . .	. . . .

[a] Dimensions in inches
[b] May be exceeded by 1/4 inch
[c] 3/16 inch nominal
[d] 1/4 inch nominal

(d) Bolted Parts: Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. Holes may be punched, subpunched and reamed, or drilled, as required by the applicable specification and shall be of a nominal diameter not more than 1/16 inch in excess of the nominal bolt diameter.

When assembled, all joint surfaces, including those adjacent to the boltheads, nuts or washers, shall be cleaned with high cycle wire brush sander or disc grinder and be free of scale, burrs, and other defects that would prevent solid seating of the parts.

Contact surfaces within friction-type joints shall be free of oil, paint, lacquer or other coatings, except as listed below:

(1) Hot dip galvanized, if contact surfaces are scored by wire brushing or blasting after galvanizing and prior to assembly. The wire brushing treatment shall be a light application of manual or power brushing that marks or scores the surface but removes relatively little of the zinc coating. The blasting treatment shall be a light "brush-off" treatment which will produce a dull gray appearance. However, neither treatment shall be severe enough to produce any break or discontinuity in the zinc surface. When ASTM A 490 bolts are specified to connect hot dip galvanized parts, the bolts shall be painted to prevent possible electrolytic action. ASTM A 490 bolts shall not be galvanized.

(2) Inorganic zinc rich paints are defined in those sections of the Steel Structures Painting Council Systems PS 12 covering zinc rich paints with inorganic vehicles.

(3) Metallized zinc or aluminum applied in accordance with AWS C2.2, except that subsequent sealing treatments described in Section IV therein shall not be used.

(e) Installation: Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. A flat washer may be used when the abutment surface adjacent to the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for lack of parallelism.

ASTM A 490 bolts shall have two hardened washers, and they shall not be retorqued.

All fasteners shall be tightened to give at least the required minimum bolt tension values shown in Table II on completion of the joint. Tightening shall be done with properly calibrated wrenches or by the "turn-of-nut" method.

(f) Calibrated Wrenches: When calibrated wrenches are used to provide the minimum bolt tension specified in Table II, their setting shall be such as to induce a bolt tension slightly in excess of this value. These wrenches shall be calibrated (at least once each working day for each bolt diameter being installed) by tightening, in a device capable of indicating actual bolt tension, not less than 3 typical bolts from the lot to be installed. Power wrenches shall be adjusted to stall or cut-off at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is

TABLE II — BOLT TENSION

ASTM A 325 BOLTS

Bolt Size (inches)	Recommended Bolt Tension for Calibrated Wrenches (Lbs.)**	Minimum Bolt Tension (Lbs.)*	Approx. Torque for Minimum Bolt Tension (Ft. Lbs.)***
½	12,500	12,050	100
⅝	20,000	19,200	200
¾	30,000	28,400	350
⅞	41,000	39,250	570
1	54,000	51,500	860
1⅛	59,000	56,450	1,060
1¼	75,000	71,700	1,490
1⅜	89,500	85,450	1,960
1½	109,000	104,000	2,600

ASTM A 490 BOLTS

Bolt Size (inches)	Recommended Bolt Tension for Calibrated Wrenches (Lbs.)**	Minimum Bolt Tension (Lbs.)*	Approx. Torque for Minimum Bolt Tension (Ft. Lbs.)***
½	15,500	14,900	120
⅝	25,000	23,700	240
¾	37,000	35,100	440
⅞	51,000	48,500	700
1	67,000	63,600	1,060
1⅛	84,000	80,100	1,500
1¼	107,000	101,800	2,120
1⅜	127,500	121,300	2,780
1½	155,000	147,500	3,690

* Equal to 70% of specified minimum tensile strength of bolt.
** Approximately 5% in excess of the minimum bolt tension.
*** Values given are for experimental approximates for nonlubricated bolts and nuts and are based on 0.0167 ft. lb. per inch bolt diameter per lb. minimum bolt tension. The actual value shall be determined during calibration of inspection wrenches.

measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to ''touch up'' bolts previously tightened which may have been loosened by the tightening of subsequent bolts until all are tightened to the prescribed amount.

Turn-of-nut: When the turn-of-nut method is used to provide the bolt tension specified in Table II, there shall first be enough bolts brought to a ''snug tight'' condition to insure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additonally by the appli-

cable amount of nut rotation specified in Table III with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE III

Nut Rotation [1] from Snug Tight Condition

Bolt Length (as measured from underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters [2]	2/3 turn	5/6 turn	1 turn

[1] Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by ½ turn and less, the tolerance should be plus or minus 30°; for bolts installed by ⅔ turn and more, the tolerance should be plus or minus 45°.

[2] When bolt lengths exceed 12 diameters, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

(g) Inspection:

(1) When the calibrated wrench method of tightening is used, the engineer shall have full opportunity to witness the calibration tests prescribed in Heading (f) above.

(2) The engineer shall observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and shall determine that all bolts are tightened.

(3) Bolts shall be inspected by applying a properly calibrated manual torque wrench in the tightening direction to 10 percent of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt head is turned by the application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolt head is turned by the application of less than the specified torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by less than the specified torque shall be tightened

and reinspected, or alternately, the fabricator or erector, at his option, may retighten all of the bolts in the connection and then resubmit the connection for inspection.

(4) The procedures for inspecting and testing the lock-pin and collar fasteners and their installation to assure that the required preload tension is provided shall be as approved by the engineer.

(5) The contractor in the presence of the engineer shall perform the inspection as called for herein and shall provide the personnel and required manual torque wrench, which will be calibrated by the Laboratory.

807.23 RIVETS AND RIVETING. The size of rivets called for on the plans shall be the size before heating. Rivet heads shall be of standard shape unless otherwise specified and of uniform size for the same diamenter of rivet. They shall be in full contact with the surface of the member.

Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale and other adhering matter. Any rivet which is scaled excessively will be rejected.

All rivets that are loose, burned, badly formed or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is defective in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking, recupping or double gunning of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines when practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over ⅜ inch.

807.24 PLATE CUT EDGES.

(a) Edge Planing: Sheared edges of plate more than ⅝ inch in thickness and carrying calculated stress shall be planed to a depth of ¼ inch. Reentrant corners shall be filleted to a minimum radius of ¾ inch before cutting.

(b) Visual Inspection and Repair of Plate Cut Edges: Visual inspection and repair of plate cut edges shall be in accordance with Section 815.

807.25 SHOP WELDING. Shop welding of metal structures, when authorized or shown on the plans, shall conform to Section 815.

807.26 ORTHOTROPIC-DECK BRIDGES.

(a) Protection of Deck Plate After Sandblasting: If sandblasting to white metal, or an equivalent method, is used to prepare the deck plate to receive a wearing surface, a protective coating shall be applied to the plate immediately after cleaning.

(b) Dimensional Tolerance Limits: Dimensional tolerance limits for orthotropic-deck bridge members shall be applied to each completed but unloaded member and shall be as specified in the DOTD Welding Procedures Manual except as superseded hereinafter. The deviation from detailed flatness, straightness, or curvature at any point shall be the perpendicular distance from that point to a template edge having the detailed straightness or curvature and which is in contact with the element at two other points. The term "element" as used herein refers to the individual panels, stiffeners, flanges, or other pieces. The template edge may have any length not exceeding the greatest dimension of the element being examined and, for any panel, not exceeding 1.5 times the least dimension of the panel; it may be placed anywhere within the boundaries of the element. The deviation shall be measured between adjacent points of contact of the template edge with the element; the distance between these adjacent points of contact shall be used in formulas to establish the tolerance limits for the segment being measured whenever this distance is less than the applicable dimension of the element specified for the formula.

(1) Flatness of Panels: The term "panel" as used herein means a clear area of steel plate surface bounded by stiffeners, webs, flanges, or plate edges and not further subdivided by any such elements. These provisions apply to all panels in the bridge; for plates stiffened on one side only such as orthotropic-deck plates or flanges of box girders, this includes the total clear width on the side without stiffeners as well as the panels between stiffeners on the side with stiffeners.

The maximum deviation from detailed flatness or curvature of a panel shall not exceed the greater of:

$$3/16 \text{ inch or } \frac{D}{144\sqrt{T}} \text{ inch}$$

where

D = the least dimension in inches along the boundary of the panel and

T = the minimum thickness in inches of the plate comprising the panel.

(2) Straightness of Longitudinal Stiffeners Subject to Calculated Compressive Stress, Including Orthotropic-Deck Ribs: The maximum deviation from detailed straightness or curvature in any direction

perpendicular to its length of a longitudinal stiffener subject to calculated compressive stress, including each orthotropic-deck rib, shall not exceed:

$$\frac{L}{480}$$

where

L = the length of the stiffener or rib between cross members, webs, or flanges.

(3) Straightness of Transverse Web Stiffeners and Other Stiffeners not Subject to Calculated Compressive Stress: The maximum deviation from detailed straightness or curvature in any direction perpendicular to its length of a transverse web stiffener or other stiffener not subject to calculated compressive stress shall not exceed:

$$\frac{L}{240}$$

where

L = the length of the stiffener between cross members, webs, or flanges.

807.27 FACING OF BEARING SURFACES. The surface of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall conform to ANSI B 46.1, Surface Roughness, Waviness and Lay, Part 1:

Steel slabs	ANSI	2,000
Heavy plates in contact in shoes to be welded	ANSI	1,000
Milled ends of compression members, stiffeners, and fillers	ANSI	500
Bridge rollers and rockers	ANSI	250
Pins and pin holes	ANSI	125
Sliding bearings	ANSI	125

807.28 ABUTTING JOINTS. Abutting joints in compression members and girder flanges and in tension members, where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed ¼ inch.

807.29 END CONNECTION ANGLES. Floor beams, stringers and girders having end connection angles shall be built to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of plus 0 inch to minus 1/16 inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than ⅜ inch, nor less than that shown on the plans after facing.

807.30 LACING BARS. The end of lacing bars shall be neatly rounded unless another form is required.

807.31 FABRICATION OF MEMBERS. Unless otherwise shown on the plans, steel plates for main members, not secondary members, shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

Fabricated members shall be true to line and free from twists, bends and open joints.

807.32 BENT PLATES. Unwelded, cold-bent, load-carrying, rolled-steel plates shall conform to the following:

(a) They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling, except that cold-bent ribs for orthotropic-deck bridges may be bent in the direction of rolling if permitted by the engineer.

(b) Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are shown in the following table:

Plate Thickness (t) (inches)	Minimum Bend Radius
Up to ½	2t
Over ½ to 1	2½t
Over 1 to 1½	3t
Over 1½ to 2½	3½t
Over 2½ to 4	4t

NOTE: Low alloy steel in thicknesses over ½ inch may require hot bending for small radii.

Allowance for springback of A514 and A517 steels should be about 3 times that for structural carbon steel. For brake press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1200°F, except for A514/A517 steel. If A514/A517 steel plates to be bent are heated to a temperature greater than 1125°F, they must be requenched and tempered in accordance with the producing mill's practice. Hot bent plates shall conform to requirement (a) above.

(c) Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.

807.33 FIT OF STIFFENERS. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall have full bearing (either

milled, ground or welded as shown on the plans or specified) on the flanges to which they transmit load or from which they receive loads. Stiffeners not intended to support concentrated loads shall, unless shown or specified otherwise, fit sufficiently tight to exclude water after being painted. As an alternate the stiffeners may be cut short, jammed to the tension flange and seal welded to the compression flange. Fillers under stiffeners shall fit within ¼ inch at each end. Welding transversely across the tension flanges of beams or girders will not be permitted.

807.34 EYEBARS. The fabrication of eyebars shall conform to the latest AASHTO specifications unless otherwise provided.

807.35 ANNEALING AND STRESS RELIEVING. Structural members which are indicated in the contract to be annealed or normalized shall have finished machining, boring and straightening done subsequent to heat treatment. Normalizing and annealing (full annealing) shall be as specified in ASTM Designation: E 44. The temperatures shall be maintained uniformly throughout the furnace during the heating and cooling so that the temperature at no two points on the member shall differ by more than 100°F at any one time.

Members of A514/A517 steels shall not be annealed or normalized and shall be stress relieved only with the approval of the engineer.

A record of each furnace charge shall identify the pieces in the charge and show the temperatures and schedule actually used. Proper instruments, including recording pyrometers, shall be provided for determining at any time the temperatures of members in the furnace. The records of the treatment operation shall be available to and meet the approval of the engineer. The holding temperature for stress relieving A514/A517 steel shall not exceed 1125°F.

Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together, shall be stress relieved in accordance with Section 815 when required by the plans or project specifications.

807.36 PINS AND ROLLERS. Pins and rollers shall be accurately turned to the dimensions shown on the plans and shall be straight, smooth and free from flaws.

Pins and rollers more than 9 inches in diameter shall be forged and annealed. Pins and rollers 9 inches or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling and before being annealed.

807.37 BORING PIN HOLES. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the

member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of end holes in tension members and inside to inside of end holes in compression members shall not vary from that specified more than 1/32 inch. Boring of holes in built-up members shall be done after the connections are completed.

807.38 PIN CLEARANCES. The diameter of the pin hole shall not exceed that of the pin by more than 0.020 inch for pins 5 inches or less in diameter or 0.03125 inch for larger pins.

807.39 SCREW THREADS. Threads for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC-ANSI B 1.1, Class 2A for external threads and Class 2B for internal threads, except that the pin ends having a diameter of 1⅜ inches or more shall be threaded 6 threads to the inch.

807.40 PILOT AND DRIVING NUTS. Two pilot nuts and two driving nuts for each size of pin shall be furnished unless otherwise specified.

807.41 CAMBER FOR ROLLED BEAMS IN SIMPLE SPAN. When required on the plans, beams shall be cambered to conform to the vertical curve or level grade as may be required after full dead load is applied. Camber shall approximate a simple regular curve from end to end of beam. The camber ordinate at mid-length of the beam, unless shown otherwise on the plans, shall be equal to the dead load deflection of the beam plus the mid-ordinate of the vertical curve, if the span is on a vertical curve. The camber ordinate may vary from the above by ¼ inch over or ¼ under.

Beams may be cambered cold or may be heated. If heat is used, the tension flange shall be heated uniformly and progressively to not more than a red heat visible in ordinary shop light (1150°F to 1250°F) while the beam is loaded to produce compression in the bottom flange. The contractor shall furnish pyrometers or temperature indicating crayons for checking the desired temperatures. The heating and loading shall be done in such a manner that the permanent camber remaining shall be within the limits specified above or shown on the plans. After the cambering operation has been concluded, the beam shall be left to air cool and no quenching process of any kind shall be permitted.

807.42 STRAIGHTENING OF OTHER MEMBERS. No quenching process of any kind shall be permitted without permission of the engineer.

807.43 ARMORED JOINTS. Armored joint assemblies shall be paired and fitted before shipping.

The plates, angles or other structural shapes shall be accurately shaped at the shop to conform to the section of the concrete floor. The fabrication and painting shall conform to the specifications covering those items. Care shall be taken to insure that the surface in the finished plane is true and free of

warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance.

807.44 SHEAR CONNECTORS. Shear connectors may be either ¾ inch or ⅞ inch studs at the contractor's option. Stud shear connectors shall conform to the following:

(a) **Construction Requirements:**

(1) Stud shear connectors shall be end welded to steel beams or girders with automatically timed stud welding equipment connected to a suitable power source. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

(2) If 2 or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only 1 gun can operate at a time and so that the power source has fully recovered from making one weld before another weld is started. The power source shall be adequate for the size of stud being welded.

(3) Studs shall not be painted or galvanized. At the time of welding, the studs shall be free from excessive rust, scale, rust pits and oil. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease or any other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder or plate to which the studs are to be welded shall be wire-brushed, peened, prick-punched or ground free of scale or rust.

(4) Welding shall not be done when the ambient temperature is below 0°F or when the surface is wet or exposed to rain or snow.

(5) While in operation, the welding gun shall be held in position without movement until the weld metal has solidified.

(6) Longitudinal and lateral spacings of studs with respect to each other and to edges of beam or girder flanges shall not vary more than ½ inch from the dimensions shown on the plans, except that a variation of one inch will be permitted where required to avoid obstruction with other attachments on the beam or where a new stud is being welded to replace a defective one. The minimum distance from the edge of a stud to the edge of a beam shall be one inch, but preferably not less than 1½ inches.

(7) The first 2 studs welded on each beam or girder, after being allowed to cool, shall be bent 45° by striking each stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and 2 successive studs successfully welded and tested before any more

studs are welded to the beam or girder. The engineer shall be promptly informed of any changes in the welding procedure at any time during construction.

(8) When the temperature of the base metal is below 0°F, preheating will be required in accordance with Section 815 and two studs in each 100 studs welded shall be bent 45° in addition to the first two bends as specified in Heading (7). Preheating must be to 70°F and temperature of the preheated base metal shall be maintained between 32°F and 70°F during the welding operation.

(9) Studs on which a full 360° weld is not obtained may, at the option of the contractor, be repaired by adding a 3/16 inch fillet weld in place of the lack of weld, using the shielded metal-arc process with low-hydrogen welding electrodes.

(10) If the reduction in the height of studs as they are welded becomes less than normal, welding shall be stopped immediately and not resumed until the cause has been corrected.

(11) Before welding a new stud where a defective one has been removed, the area shall be ground smooth and flush or in the case of a pull-out of metal, the pocket shall be filled with weld metal using the shielded metal-arc process with low-hydrogen welding electrodes and then ground flush. In compression areas of flanges, a new stud may be welded adjacent to the defective area in accordance with Heading (6) in lieu of repair and replacement on existing weld area.

(b) Inspection Requirements:

(1) After the studs have been welded to the beam a visual inspection shall be made and each stud shall be given a light blow with a hammer. Any stud which does not have a complete end weld, any stud which does not emit a ringing sound when given a light blow with a hammer, any stud that has been repaired by welding or any stud which has less than normal reduction in height due to welding, shall be struck with a hammer and bent 15° from the correct axis of installation, and in the case of a defective or repaired weld the stud shall be bent 15° in the direction that will place that defective portion of the weld in the greatest tension. Studs that crack either in the weld or in the shank shall be replaced.

Studs which are to be replaced for the above reasons or because they have been otherwise rendered unacceptable may be manually welded with a full 360° ¼ inch fillet weld for ¾ inch studs and with a full 360° 5/16 inch fillet weld for ⅞ inch and 1 inch studs as specified in Headings (b)(9) and (b)(11) of this Subsection.

(2) The engineer, at his option, may select additional studs to be subjected to the bend test specified above.

(3) The studs tested that show no sign of failure may be left in the bent position.

(4) If during the progress of the work, inspection and testing indicates in the judgment of the engineer that the shear connectors being obtained are not satisfactory, the contractor will be required at his expense to make such changes in welding procedure, welding equipment and type of shear connector as necessary to secure satisfactory results.

(5) At the option and the expense of the purchaser, the manufacturer of the studs may be required at any time to submit sample studs for requalification in accordance with established procedure.

807.45 MARKING AND SHIPPING. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The contractor shall furnish to the engineer as many copies of materials orders, shipping statements and erection diagrams as the engineer may direct. The weights of the individual members shall be shown on the statements. Members weighing more than 3 tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

Bolts and rivets of one length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts and packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

807.46 PAINTING. Shop and field paints and their application shall conform to Section 811.

ERECTION

807.47 HANDLING AND STORING MATERIALS. Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease and other foreign matter and shall be protected as far as practicable from corrosion. It shall be properly drained.

Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection.

807.48 FALSEWORK. The falsework shall be designed properly, constructed substantially and maintained for the loads which will come upon it.

807.49 BEARINGS AND ANCHORAGES. Bearings shall be set level, in exact position, and must have full and even bearing on the masonry.

Elastomeric bearing pads, if used, shall be set directly on the concrete masonry.

Cast iron or steel or rolled steel bearings shall be bedded on the masonry with alternate layers of red lead and canvas, or a single thickness of sheet lead, or preformed fabric bearing pad. The performed fabric bearing pad shall conform to Subsection 1017.06(b).

The contractor shall drill holes for anchor bolts and set them in portland cement grout, or pre-set them as shown on the plans or as specified.

Location of anchors and setting of rockers or rollers shall take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom chord or bottom flange due to dead load after setting; the intention being that, as near as practicable, at mean temperature and under dead load the rockers and rollers shall set vertical and anchor bolts at expansion bearings will center their slots. Care shall be taken that full and free movement of the superstructure at the movable bearings is not restricted by improper setting or adjustment of bearings or anchor bolts and nuts.

Bearings shall not be placed on masonry bearing areas which are irregular or improperly formed.

807.50 STRAIGHTENING BENT MATERIAL AND CAMBERING.

(a) Straightening Bent Material: The straightening of plates, angles, other shapes and built-up members, when permitted by the engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the engineer, by the careful planned and supervised application of a limited amount of localized heat, except that heat straightening of A514/A517 steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the engineer. In no case shall the maximum temperature of the A514/A517 steel exceed 1125°F, nor shall the temperature exceed 950°F at the weld metal or within 6 inches of weld metal. Heat shall not be applied directly on weld metal. In all other steels, the temperature of the heated area shall not exceed 1200°F (a dull red) as controlled by temperature indicating crayons, liquids or bi-metal thermometers.

Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

(b) **Cambering:** Correction of errors in camber in welded beams and girders of A514/A517 material shall be done only under rigidly controlled procedures, each application subject to approval of the engineer.

807.51 ASSEMBLING STEEL. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.

Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets or permanent bolts in splices of butt joints of compression members and rivets or permanent bolts in railings shall not be driven or tightened until the span has been swung.

Splices and field connections shall have at least 50 percent of the holes filled with bolts and pins (either erection or untorqued permanent bolts) and an adequate number (minimum of 10 percent) of cylindrical erection pins for fit-up and alignment. Splices and connections carrying traffic during erection shall have 75 percent of the holes filled. Main member splices shall have all holes filled with bolts and cylindrical erection pins (half bolts and half pins) for fit-up and alignment.

Fitting-up bolts shall be of the same nominal diameter as the rivets or permanent bolts and cylindrical erection pins shall be 1/32 inch larger.

Permanent field bolting shall be performed in accordance with Subsection 807.22.

807.52 RIVETING. Pneumatic hammers shall be used for field riveting except when the use of hand tools is permitted by the engineer. Rivets larger than ⅞ inch in diameter shall not be driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. In other respects riveting shall conform to Subsection 807.23. Field rivets shall not be smaller than the heads of the shop rivets. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

807.53 PIN CONNECTIONS. Pilot and driving nuts shall be used in driving pins. They shall be furnished by the contractor without charge. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

807.54 FIELD WELDING. Field welding of steel structures, when

authorized or as shown on plans, shall conform to Section 815.

807.55 MISFITS. The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the inspector and his approval of the method of correction obtained. The correction shall be made in his presence. The contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

807.56 SETTING BENCH MARKS. A bench mark bolt, furnished and delivered by the contractor, shall be set by the contractor without extra compensation on each bridge. The bench mark bolt shall be either hex head or square head 4 inch by ⅝ inch threaded galvanized bolt. It shall be located on the downstream side and at the end of the bridge on the right descending bank. If the bridge carries a concrete floor the bench mark plate shall be set at the end of the curb. No permanent plates or markers other than those furnished or specified will be permitted on any structure.

807.57 WEATHERING STEEL. When ASTM A 588 weathering steel is specified to be left unpainted, the following modifications in the requirements of this section shall apply.

(a) Materials: Steel to be completely embedded in concrete shall be either ASTM A36 or A588 steel. Anchor bolt assemblies and other steel partially embedded in concrete shall be A588 steel.

(b) High Strength Bolts: High strength bolts shall be ASTM A325, Type 3.

(c) Stiffeners: To facilitate drainage adjacent to stiffeners, the lower end of transverse stiffeners shall be clipped at least 1½'', and longitudinal stiffeners shall be terminated at least 1'' short of transverse stiffeners.

(d) Cleaning of Exposed Surfaces: Exposed surfaces of weathering steel to be left unpainted shall be cleaned of all grease, oil, paint or other soilage.

All outside surfaces of exterior girders and the bottom surface of the bottom flange of exterior girders shall be blast cleaned, either before or after erection, in accordance with Steel Structures Painting Council Specifications SP 6. Blast cleaned surfaces shall be kept free of grease, oil, markings, paint or other soilage; and all such soilage of blast cleaned surfaces shall be removed by approved methods. Concrete splatter shall be washed off immediately.

At the contractor's option, any or all other weathering steel surfaces may be blast cleaned.

(e) Restoration of Concrete Finish: After all weathering steel has been in place for at least 30 days, the contractor shall remove all discolorations of the concrete surfaces due to the weathering of the steel and shall restore the finish of these concrete surfaces.

807.58 METHOD OF MEASUREMENT.

(a) Weight Basis: All structural steel will be measured by the weight of metal in pounds remaining in the completed and accepted structures. The weight will be computed on the basis of theoretical net weight from the approved shop drawings. No allowance will be made for rivets, bolts, nuts, washers or welds and no deductions will be made for rivet holes, bolt holes, beam copings, cut flanges or edge preparation for welding. Deduction will be made for pin holes. All plates shall be estimated from the sizes billed and deductions made for cut corners.

Such miscellaneous parts as ladders, stairways, platforms, structural supports and brackets for machinery and power equipment including pit pumps, steel framework for counterweights, floor plates, keeper plates and their tap bolts, sheet metal covers for gears, drum switches and other parts where required, shim plates, bearing plates for approach spans of whatever material is required, curb angles, anchor bolts including those for roadway gates and bronze and cast iron for expansion plates will be classified and measured as Steel (A 36).

No measurement of structural steel of any class will be allowed for temporary work of any kind or for additional weight in members provided for erection purposes.

No allowance will be made in the pay quantity for any items not remaining in the finished structure except as hereinafter provided.

No allowance will be made for shop or field paints, galvanizing or other coatings.

No allowance will be made for over-run on plates or rolled sections.

When full-sized test of built-up structural members and eyebars are required by the contract, any full-size members tested to destruction will be measured if the test proves satisfactory. However, if the test proves the member to be unsatisfactory, the members represented by it will be rejected and no measurement or allowance will be made for such members.

Steel (A 36): This steel shall include all metal classified as such on the plans and unless otherwise noted on the plans, such minor items as anchor materials including pins, rollers, metal railings, steel plates and shapes for expansion joints, ladders, wrought iron sheets, checkered floor plates, bronze castings and plates, steel castings, and iron castings (except cast iron drains in floors) and all other metal items necessary to complete this portion of the structure.

Steels (A 440), (A 441), (A 572) and (A 588): Measurement of these steels will include all steel classified as such on the plans or in the project specifications.

Metal weights will be computed on the following basis:

Aluminum, cast or wrought	173.0 pounds/cu. ft.
Bronze, cast	536.0 pounds/cu. ft.
Copper-alloy	536.0 pounds/cu. ft.
Copper, sheet	558.0 pounds/cu. ft.
Iron, cast	445.0 pounds/cu. ft.
Iron, malleable	470.0 pounds/cu. ft.
Iron, wrought	487.0 pounds/cu. ft.
Lead, sheet	707.0 pounds/cu. ft.
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0 pounds/cu. ft.
Zinc	450.0 pounds/cu. ft.

Shear connectors will not be measured for payment, but will be considered as incidental to the work.

(b) Lump Sum Basis: When payment is specified to be made by the lump sum, no weight measurement of metal will be made. The estimate of the weight of structural metalwork shown on the plans is approximate and no guarantee is made that it is the correct weight to be furnished. It will be the bidder's responsibility to determine the correct weight of each grade of metal to be furnished under the lump sum item. No adjustment in contract price will be made due to errors in the estimated weight shown on the plans. Shop bills will not be required.

807.59 BASIS OF PAYMENT.

(a) Weight Basis: The accepted quantities of the various classifications of structural metals will be paid for at the respective contract unit prices per pound.

(b) Lump Sum Basis: The completed and accepted items will be paid for at the contract lump sum price, which includes furnishing, fabricating, erecting, painting, galvanizing or other coating (if required) of all necessary materials; furnishing all required labor, plants, equipment, tools, staging, falsework, forms, power welding, bolts and other hardware; and the performance of all work necessary to complete the item.

If changes in the work are ordered by the engineer, which vary the weight of steel to be furnished, the lump sum payment will be adjusted as follows:

The value per pound of the increase or decrease in the weight of structural steel involved in the change will be determined by dividing the contract lump sum amount by the estimated weight shown on the plans. The adjusted contract lump sum payment will be the contract lump sum amount

plus or minus the value of the steel involved in the change, and no additional compensation will be made on account of said change.

If a change in the grade of steel to be furnished is ordered by the engineer, resulting in additional cost to the contractor, compensation will be made in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
807(1)	Steel (A 36)	Pound
807(2)	Steel (A 440)	Pound
807(3)	Steel (A 441)	Pound
807(4)	Steel (A 572)	Pound
807(5)	Steel (A 588)	Pound
807(6)	Structural Metalwork	Lump Sum

Section 808

Steel Grid Flooring

808.01 DESCRIPTION. This work consists of furnishing and installing steel grid flooring of the open type or the concrete-filled type, as specified, in accordance with these specifications and in reasonably close conformity with the details shown on the plans.

Before fabrication or construction is undertaken, the contractor shall submit complete shop and assembly details conforming to Subsection 801.03 to the Bridge Design Engineer for approval.

808.02 MATERIALS. Steel grid flooring shall conform to Subsection 1013.22.

Concrete in filled steel grid floors shall be Class A conforming to Sections 805 and 901; however, the maximum size coarse aggregate shall be ⅜ inch.

The upper edges of all members forming the wearing surface of an open type grid flooring shall be fabricated or treated to give the maximum skid resistance.

808.03 FABRICATION. Deviations from these specifications to conform to manufacturer's specifications will not be permitted without approval of the Bridge Design Engineer.

808.04 NOTICE OF BEGINNING OF WORK. The contractor shall give the Bridge Construction Engineer at least 10 days advance written notice of the beginning of work at the mill or in the shop so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before shop drawings have been approved and before the Bridge Construction Engineer has been notified.

808.05 FACILITIES FOR INSPECTION. The contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop and the inspector shall be allowed free access to the necessary parts of the works.

808.06 STORAGE OF MATERIALS. Steel grid flooring shall be stored at the bridge site, above ground, upon platforms, skids or other supports. It shall be kept free from dirt, grease and other foreign matter and shall be protected as far as possible from corrosion. It shall be properly drained.

808.07 STRAIGHTENING MATERIAL. Steel grid flooring sections, before being installed, shall be straight, except for camber if specified. If straightening is necessary, it shall be done by methods that will not damage the metal.

808.08 ARRANGEMENT OF SECTIONS. Where the main elements are normal to centerline of roadway, the units generally shall be of such length as to extend over the full width of the roadway for roadways up to 40 feet, but in every case the units shall extend over at least 3 panels. Where joints are required, the ends of the main floor members shall be welded at the joints over their full cross-sectional area or otherwise connected to provide full continuity.

Where the main elements are parallel to centerline of roadway, the sections shall extend over not less than 3 panels, and the ends of abutting units shall be welded over their full cross-sectional area or otherwise connected to provide full continuity in accordance with the design.

808.09 PROVISION FOR CAMBER. Unless otherwise provided on the plans, provision for camber shall be made as follows:

Steel units so rigid that they will not readily follow the camber required shall be cambered in the shop. To provide a bearing surface parallel to the crown of the roadway, the stringers shall be canted or provided with shop-welded beveled bearing bars. If beveled bars are used, they shall be placed along the centerline of the stringer flange, in which case the design span length shall be governed by the width of the bearing bar instead of by the width of the stringer flange.

Longitudinal stringers shall be mill cambered or provided with bearing strips so that the complete floor after deadload deflection shall conform to the longitudinal camber shown on the plans.

808.10 FIELD ASSEMBLY. Areas of considerable size shall be assembled before the floor is welded to its supports. The main elements shall be made continuous and sections shall be connected together along their edges by welding of bars or by riveting them. The connections shall meet with the approval of the engineer. The rivets may be cold driven.

808.11 CONNECTION TO SUPPORTS. The floor shall be connected to its steel supports by welding. Before any welding is done, the floor shall either be loaded to make a tight joint with full bearing or it shall be clamped down. The location, length and size of the welds shall be subject to the approval of the Bridge Design Engineer, but in no case shall they be less than the manufacturer's standards.

The ends of all the main steel members of the slab shall be securely fastened together at the sides of the roadway for the full length of the span by means of steel plates or angles welded to the ends of the main members, as shown on the plans.

808.12 WELDING. All shop and field welding shall conform to Section 815.

Surfaces to be welded shall be free from paint, grease, loose scale, rust and other material that will prevent a proper weld. A thin coating of linseed oil, without pigment, need not be removed; however, any clinkers or slag caused by flame cutting or other causes shall be removed before welding.

Field welding shall conform to the approved method and location as shown on the shop drawings.

808.13 PAINTING. The open steel grid floor shall be cleaned and painted in accordance with Section 811 and the following requirements.

The cleaning shall be done by the Near-White Blast Cleaning Method or Pickling Method at the option of the contractor.

For the filled type of grid flooring, only the underside of the bottom plate and the other faces of headers, trim bars and end bars shall be painted.

808.14 USE OF ALTERNATE SECTIONS. If the contractor desires to substitute grid flooring of a type different from the types specified or allowed in the plans, shop drawings of the proposed grid flooring shall be submitted to the Bridge Design Engineer for approval of such substitution, and any structural changes in the floor system necessitated by such substitution shall be incorporated in the shop details. The proposed floor system shall be designed in accordance with the current AASHTO Standard Specifications for Highway Bridges for the specified design load.

808.15 CONCRETE FILLER. Where indicated on the plans, concrete filler shall be placed in the open grid.

Floor types with bottom flanges not in contact shall be provided with bottom forms of metal or wood to retain the concrete filler without excessive leakage.

If metal forms are used, they shall fit tightly on the bottom flanges of the floor members and be placed in short lengths so as to extend only about 1 inch onto the edge of each support, but in all cases the forms shall be such as will result in adequate bearing of the slab on the support.

The concrete shall be thoroughly consolidated by vibrating the steel grid floor. The vibrating device and the manner of operating it shall be subject to approval.

808.16 METHOD OF MEASUREMENT. The quantity of steel grid flooring for payment will be the design area as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

Concrete used for filling steel grid flooring will not be measured for payment, but will be considered as incidental to the work.

808.17 BASIS OF PAYMENT. The accepted quantity of steel grid flooring will be paid for at the contract price per square foot, which includes furnishing and fabricating all steel materials, including base plates, trim angles, trim plates, painting or other coating (if required), and all welding and riveting, and any additional materials or fabrication in the floor system necessitated by the use of an approved alternate grid flooring type.

Payment will be made under:

Item No.	Pay Item	Pay Unit
808(1)	Steel Grid Flooring	Square Foot

Section 809

Movable Bridges

809.01 DESCRIPTION. This work consists of the furnishing, fabrication and erection of movable span bridges and of all appurtenances required for their operation such as machinery, operating house, traffic barriers, power plant and machinery houses.

The requirements for fixed span bridges, as given in these specifications, shall apply to movable bridges except as herein provided.

809.02 SILENCE OF SPECIFICATIONS. The apparent silence of the project specifications as to any detail or the omission from them of a detailed description of any point shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of first quality are to be used in such cases.

809.03 OBJECTION TO SPECIFICATIONS. If the contractor has any objections to any features of the machinery, operating house, traffic barriers or power equipment as required by these specifications, he must state his objections in writing to the engineer before any parts are ordered.

809.04 GUARANTEE OF MACHINERY, OPERATING HOUSES, TRAFFIC BARRIERS AND POWER EQUIPMENT. All machinery, operating houses, traffic barriers and power plant equipment shall be satisfactory and the contractor shall furnish and install without charge any and all parts which may fail or otherwise prove defective within one year of the date on which the bridge is finally accepted. If it should be found that the parts failed due to defective material or faulty workmanship and if such parts should, within the said one year, cause any breakdown or accident, the contractor will not only be required to furnish and install the defective part but will also be held pecuniarily responsible to the Department for all expense to the latter due to such failure. Routine maintenance during the guarantee period will be performed by the Department.

809.05 BOND. As a guarantee to cover the replacement of defective or broken parts as stated above, the contractor will be required to furnish satisfactory bonding in full amount of the price bid for machinery, operating houses, traffic barriers and power equipment. This bond shall remain in effect for a period of one year from date of final acceptance of the bridge and

shall be filed in the offices of the Department prior to the payment of the final estimate.

809.06 DRAWINGS. Shop drawings, brochures and work drawings shall be furnished in accordance with Subsection 801.03.

809.07 MAINTENANCE AND OPERATION INSTRUCTION BOOKLETS. Maintenance and operation instruction booklets shall be furnished in accordance with Subsection 801.03.

809.08 INSTRUCTOR AND INSTRUCTION TO OPERATORS. The contractor shall notify the engineer when the span, including the power plant, operating house, traffic barriers and machinery, is sufficiently complete so that the span is operable, in order that the permanent bridge operators may be assigned for instruction. At this time, the contractor shall furnish a competent person, experienced in the operation of equipment of this character, for a period of 5 working days of 8 hours each to instruct the owner's bridge operators in the complete and correct operation of the bridge. This 5-day period of instruction shall be prior to final inspection. This provision shall also apply for manually operated movable bridges.

809.09 METALS. All structural and miscellaneous metals to be used in the manufacture of parts for movable bridges shall be as listed in Part X Materials, current AASHTO Standard Specifications for Design of Movable Bridges, the project specifications and as shown in the plans.

809.10 WIRE ROPE AND ATTACHMENTS. Wire rope and attachments shall be as specified in Section 1009, the project specifications and as shown on the plans.

809.11 GENERAL FABRICATION AND ERECTION REQUIREMENTS. Except as otherwise provided herein, the fabrication and erection of structural parts shall conform to the requirements for fixed-span bridges.

809.12 MANUFACTURE AND FABRICATION OF MACHINERY AND TRAFFIC BARRIERS.

(a) Shop Practice: The manufacture of machinery and traffic barrier parts shall be in accordance with the current and best practice of modern foundries and machine shops. The general manufacture of machined parts shall be in accordance with ANSI standards for the various items required.

(b) Inspection: The contractor shall give the engineer 10 days advance written notice before beginning the manufacture of any item, so that inspection may be provided. The contractor shall furnish facilities for the inspection of material and workmanship. The inspectors shall be allowed free access to plant facilities for adequate inspection of the work. This inspection shall be at the option of the Department and shall in no way relieve the contractor of any responsibility placed upon him by his contract.

(c) Fit Tolerances for Accurate Work: The allowances which should be made for different kinds of fits are tabulated hereinafter. They are based on the use of the hole as the nominal size and give the amounts by which the shaft should be less than (minus) or greater than (plus) the nominal hole size. If the shaft is selected as the base, the allowances for the hole will be of the same magnitude but of opposite sign. The permissible tolerance is the difference between the minimum and maximum allowances.

(d) Classification of Fits and Surface Finishes:

Classifications	ANSI Surface Finish
Loose Fit (Class 1), Large Allowance. This fits provides for considerable freedom and embraces certain fits where accuracy is not essential. Suitable for ordinary bearings on shafts which are subject to light journal pressures (600 psi or less).	Bearings—16 Journals— 8
Free Fit (Class 2), Liberal Allowance. For running fits with speeds of 600 rpm or over and journal pressure of 600 psi or over. Also use this fit for heavily loaded journals on shafts and trunnions.	Bearings—16 Journals— 8
Medium Fit (Class 3), Medium Allowance. For running fits under 600 rpm and journal pressures less than 600 psi; also for sliding fits.	Bearings—16 Journals— 8
Snug Fit (Class 4), Zero Allowance. This is the closest fit which can be assembled by hand and necessitates work of considerable precision.	125
Wringing Fit (Class 5), Zero to Negative Allowance. This is also known as a tunking fit and is practically metal to metal.	125
Tight Fit (Class 6), Slight Negative Allowance. Light pressure is required to assemble these fits.	125
Medium Force Fit (Class 7), Negative Allowance. Considerable pressure is required to assemble these fits, and the parts are considered permanently assembled.	125
Heavy Force and Shrink Fit (Class 8), Considerable Negative Allowance. These fits are used for steel holes where the metal can be highly stressed without exceeding its elastic limit.	125
Shafts Outside Bearings:	250

Allowances for the various classifications of fits shall be in accordance with the following tables.

ALLOWANCES FOR VARIOUS TYPES OF FIT

(Allowances, Tolerances and Interference are given in ten-thousandths of an inch)

Size, Inches	Loose Fit (Class 1)		Free Fit (Class 2)			Medium Fit (Class 3)			Snug Fit (Class 4)			Wringing Fit (Class 5)			Tight Fit (Class 6)		Medium Force Fit (Class 7)		Heavy Force & Shrink (Class 8)
	Allowance	Allowance plus Tolerances		Allowance	Allowance plus Tolerances		Allowance	Allowance plus Tolerances		Allowance	Allowance plus Tolerances		Allowance	Allowance plus Tolerances		Average Interference		Average Interference		Average Interference
	Tightest fit	Loosest fit		Tightest fit	Loosest fit		Tightest fit	Loosest fit		Tightest fit	Loosest fit		Tightest fit	Loosest fit		Selected fit		Selected fit		Selected fit
	(+)	(+)		(+)	(+)		(+)	(+)		(+)	(+)		(+)	(+)		(−)		(−)		(−)
1-1/16	30	90		15	43		10	26		0	10		4	6		3		6		11
1-3/16	30	90		16	44		10	28		0	10		4	6		3		6		13
1-3/8	30	90		18	48		12	30		0	12		4	7		4		8		15
1-5/8	30	90		18	48		12	30		0	12		4	7		4		9		18
1-7/8	40	100		20	52		13	33		0	13		5	7		5		10		20
2-1/8	40	100		22	54		14	34		0	13		5	8		5		11		23
2-3/8	40	100		24	58		15	35		0	13		5	8		6		13		25
2-3/4	50	110		26	62		17	39		0	13		5	8		6		13		25
3-1/4	50	130		29	67		19	43		0	15		6	9		7		15		30
3-3/4	60	140		32	72		21	45		0	15		6	9		8		18		35
4-1/4	60	140		35	77		23	49		0	16		6	10		10		20		40
4-3/4	70	150		38	80		25	51		0	17		7	10		11		23		45
5-1/2	70	150		41	85		26	54		0	17		7	10		13		25		50
6-1/2	80	180		46	94		30	60		0	18		7	11		15		30		60
7-1/2	90	190		51	101		33	63		0	19		8	11		18		35		70
8-1/2	100	200		56	108		36	68		0	20		8	12		20		40		80

(+) denotes clearance or amount of looseness
(−) denotes interference of metal or negative allowance

For larger than 8½ inch diameter use following:

Formulas for Recommended Allowances and Tolerances

Class of Fit	Method of Assembly	Allowance	Selected Average Interference of Metal	Hole Tolerance	Shaft Tolerance
(1) Loose	Strictly Interchangeable	$0.0025\sqrt[3]{d^2}$		$0.0025\sqrt[3]{d}$	$0.0025\sqrt[3]{d}$
(2) Free	Strictly Interchangeable	$0.0014\sqrt[3]{d^2}$		$0.0013\sqrt[3]{d}$	$0.0013\sqrt[3]{d}$
(3) Medium	Strictly Interchangeable	$0.0009\sqrt[3]{d^2}$		$0.0003\sqrt[3]{d}$	$0.0003\sqrt[3]{d}$
(4) Snug	Strictly Interchangeable	0.0000		$0.0006\sqrt[3]{d}$	$0.0004\sqrt[3]{d}$
(5) Wringing	Selective assembly		0.0000	$0.0006\sqrt[3]{d}$	$0.0004\sqrt[3]{d}$
(6) Tight	Selective assembly		0.00025d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$
(7) Medium force	Selective assembly		0.0005d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$
(8) Heavy force or shrink	Selective assembly		0.001d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$

d = diameter of fit in inches.
The formulas for allowance values give the ideal condition of fit for Classes 1 to 4.
The formulas for selected average interference of metal give the ideal condition for fit for Classes 5 to 8.

809.13 SHAFTS, TRUNNIONS AND JOURNALS. Shafts and trunnions shall be made with fillets where abrupt changes in section occur.

Unless otherwise specified, the journals of shafts and trunnions shall be polished to ANSI No. 8 surface finish after being machined. For shafts and trunnions more than 8 inches in diameter, there shall be a hole bored lengthwise through the center. The diameter of the hole shall be approximately 1/5 the diameter of the shaft or trunnion.

809.14 COUPLINGS. The faces of flange couplings shall be planed to ANSI No. 125 surface finish and holes bored in pairs.

809.15 HUBS. Hubs of wheels, pulleys, gears and couplings shall be bored true to center for Class 7 fit upon their shafts or axes. The ends of hubs shall be finished, as required.

809.16 BUSHINGS. Bushings shall be bored to fit the matching shaft or journal to within the tolerances specified.

The bearing housing shall be bored to fit the outside of the bushing. The contact edges of oil grooves and bushings shall be rounded. Babbitt metal, when required, shall be poured in the bearing in such a way that the thickness of the bushing after boring will be uniform.

809.17 BEARING HOUSING. The rubbing and bearing surfaces shall have an ANSI No. 16 surface finish and the joints between cap and base of bearings shall have an ANSI No. 125 surface finish. The holes in cap and base shall be drilled. The holes in bearings, for bolts fastening them to their supports, shall be drilled or reamed to size and bolts turned as required in Subsection 809.23. The holes in the supports shall be reamed to fit after the bearings have been adjusted. Bearings shall be finished on both ends. Trunnion bearings shall be bored parallel with the base.

809.18 GEAR TEETH. The teeth of gears transmitting power for the operation of the bridge shall be machine cut. The periphery and ends of teeth of gears shall be turned. The pitch circle shall be scribed on the teeth. The teeth of the rack may be either cast or cut and finished, as specified.

809.19 BEVEL GEARS. The teeth of bevel gears shall be cut by a planer having a rectilinear motion in lines through the apex of the cone. Rotating milling cutters shall not be used for making bevel gears.

809.20 WORMS AND WORM WHEELS. Threads on worms shall be machine cut and the teeth of worm wheels shall fit the worm accurately with surface or line contact.

809.21 KEY AND KEYWAYS. Keys shall be planed and keyways machine cut. The finish of the keys and keyways shall be such as to give the key a Class 7 fit on all the sides. Tapered keys shall bear on the top, bottom and sides; parallel faced keys on the sides only.

809.22 CASTINGS. Castings shall be cleaned and all fins and other irregularities removed so that they will have clean, smooth, uniform surfaces suitable for this class of work. Castings which are to be attached to structural steel or other castings shall have their contact surfaces finished to ANSI No. 250 surface finish. Unfinished edges of bases, ribs and similar parts shall be neatly cast with rounded corners. Inside angles shall have proper fillets. Bosses shall be finished to the correct plane. Surfaces of castings in contact with masonry shall have ANSI No. 2000 finish.

809.23 BOLT HOLES AND TURNED BOLTS. Holes for unfinished bolts shall be drilled or reamed not more than 1/16 inch larger in diameter than the bolt. The diameter of the shank of turned bolts shall be of such size as to make a Class 6 fit for the holed parts.

809.24 AIR BUFFERS. The workmanship on air buffers shall be so accurate that the weight of the cylinder and its attachments will be sustained by the confined air for 6 minutes, with the cylinder lubricated with a light oil

and with a piston travel not more than that which occurs during the closure of the bridge. The valves must be closed and the buffers balanced so that the whole weight is carried by the piston rod.

809.25 BRAKES AND BRAKE LININGS. Brake shoes or bands shall be made so as to bear uniformly on the brake wheel. Brake linings shall preferably be attached to the shoes by means of copper rivets or approved bonding and in such manner as to be easily accessible for replacement.

809.26 RACK AND TRACK. In swing bridges, track segments shall be finished on the top and at the ends to ANSI No. 250 surface finish. The track centerline shall be scribed on the surface.

The tooth segments forming the rack shall be fitted accurately. Particular care shall be taken to have the pitch of the teeth at the joints accurate and continuous. The tip of rack teeth shall be machine finished to a true circle. The pitch line shall be scribed on the teeth.

The backs of racks which bear on metal surfaces and the surfaces in contact with them shall be finished to ANSI No. 1000 surface finish. Surfaces which bear on masonry shall have ANSI No. 2000 surface finish.

809.27 PIVOT PEDESTALS. The disc seats shall be so finished as to insure a horizontal position of the span.

809.28 DISCS. Discs for pivot bearings shall be fitted accurately, finished to gage and shall be ground accurately to the final finish. The sliding contact surface of steel and phosphor-bronze discs shall be polished to ANSI No. 8 surface finish. Disc centers shall be assembled, fitted accurately and match-marked.

809.29 BALANCE WHEELS. The periphery and faces of balance wheels shall be turned to ANSI No. 250 surface finish, the corners shall be rounded and the centerline of the balance wheels shall be scribed on the periphery. The hubs shall be bored accurately and faced on both ends.

809.30 PLANING GIRDERS. In built track girders and segmental girders of rolling bascule bridges, the edges of the webs, side plates, and angles shall be planed to ANSI No. 250 surface finish so that full bearing on the track plate will be assured.

809.31 TREAD PLATES AND TRACK SEGMENTS. The contact surfaces of tread plates and track segments shall be planed to ANSI No. 250 surface finish so that full bearing on the tread plates will be assured.

809.32 OIL OR GREASE GROOVES IN TRUNNIONS. The oil or grease grooves in the surfaces of trunnions and similar large bearings shall be machine cut. After machining, small inequalities may be removed by chipping and filing. The grooves shall be smooth, especially the rounded corners.

809.33 BORING AND ASSEMBLY OF TRUNNION BEARINGS.

When trunnion bearings are to be mounted on flexible supports, they shall be so bored that when the trunnion girder or support deflects under full dead load, the axes of the trunnions will be coincident.

Trunnions shall be fitted to their bearings in the manufacturer's shop. If they are to be disassembled for shipment, they shall be match-marked for field erection.

809.34 SHEAVES. The grooves in sheaves shall be turned. The shape of the grooves shall conform as closely as feasible to the rope section so that while the ropes run freely in the grooves, the sides of the grooves shall prevent the wire ropes from flattening under static loads, as when supporting counterweights. Segmental sheaves shall be completely assembled and, if of welded construction, shall be stress relieved before the grooves are turned. The variation from the required diameter shall not exceed plus or minus 0.01 inch.

Sheaves shall have an ANSI Class 8 fit on shafts up to and including 10 inches, and an ANSI Class 7 fit on shafts over 10 inches.

Both ends of hub shall be finished as specified.

809.35 HOLES FOR SHEAVES FOR VERTICAL LIFT BRIDGES. In vertical lift bridges, the holes in the girders and columns for the bolts connecting the main sheave bearings to their supporting girders shall be drilled from the solid through cast iron or steel templates on which the bearings were set and accurately aligned when the holes in the bearings were bored. The bolt holes and the bolts shall be the same diameter and the bolts driven in place without injury to the bolts, the bearings, the girders or the columns.

809.36 SHOP ASSEMBLY OF MACHINERY. When specified, machinery parts shall be assembled in the shop on their structural supports. They shall be aligned, adjusted and fitted in their correct relative positions and holes in the structural supports shall be drilled to correctly match the holes in the machinery parts. The parts shall be match-marked before disassembling and they shall be erected in the field in the same relative positions.

When specified, the complete center of swing spans, including rack and track segments, shall be assembled in the shop and aligned, fitted, drilled and the parts match-marked. When specified, the complete gear train shall be assembled in the shop and subjected to a specified time run.

When assembling in the shop is not required, the holes in the structural supports shall be left blank to be drilled in the field after the machinery parts have been set to correct alignment and adjustment or subpunched or drilled ¼ inch smaller and reamed to size in the field after erection.

809.37 HYDRAULIC PIPING. The inside of hydraulic piping shall be bright, clean and free from grease, drawing compounds, oxide, scale and carbon deposits. Any pipe which has been pickled to remove scale shall be

treated to eliminate pickle brittleness. The inside of the pipe shall then be coated with clean oil and the ends of the pipe sealed for protection against corrosion during shipment to and storage at the job site. The corrosion preventive oil used shall be such that after extended storage periods it can be readily removed with an alkaline cleaning solution or with benzine. Welding of hydraulic piping shall conform to Section 815.

809.38 PROTECTION OF MACHINERY, POWER PLANT AND TRAFFIC BARRIER PARTS DURING SHIPMENT. All finished rubbing and bearing surfaces of machinery and traffic barrier parts shall be given a protective coating before shipment. The bearing surfaces of trunnions, heavy axles and shafts, in addition to the protective coating, shall be protected by wood lagging securely attached.

The bearing surfaces of other shafts, axles and similar parts shall be covered with burlap or other satisfactory protecting material. Small machinery and traffic barrier parts shall be boxed or crated.

All electrical apparatus shall be thoroughly protected by boxes or crates. Electric motors not designed to be operated fully exposed to the weather shall be protected by waterproof coverings.

809.39 ERECTION.

(a) Position of Span During Erection: Movable bridges may be erected in either the open or closed position, as may be approved by the navigation authorities and the engineer.

(b) Protection of Machinery, Operator House and Traffic Barrier Parts During Erection: Parts which are protected from the weather in the completed structure or during shipment from the shop shall be likewise protected during unloading, field storage and erection. Special care shall be exercised in protecting electrical parts. Wire ropes shall be stored not less that 16 inches above the ground and free from conditions likely to produce corrosion of the wires of decay of the hemp cores. While being unwound or otherwise handled during the operations incident to their installation upon counterweights, sheaves and drums, they shall not be kinked or bent to short radius curves nor shall they be dragged over stones, rough metal surfaces or other material likely to produce abrasions upon the exposed surfaces of the wires.

(c) General Requirements for Machinery and Traffic Barrier Erection: The alignment and adjustment of machinery, electrical equipment and traffic barriers shall be done by skilled mechanics. Trunnion bearings and all important shaft bearings shall be set using piano wire or optical methods to determine their correct adjustment.

Shims shall be of sheet steel and brass shim stock. The contractor shall have a supply of shims varying in size and thickness with a minimum thickness of 3/1000 of an inch. Shims shall be used for aligning and adjust-

ing machinery to its proper place prior to securing it rigidly in position with bolts or other fastenings. Brass shim stock shall be used for the final adjustment. To prevent localization of stresses in the machinery and traffic barrier parts, the shims shall not be less in dimensions than the bearing area being shimmed.

All minor pockets and depressions formed as a result of erection and which may collect moisture or oil shall be drained even when drainage is not called for on the plans, provided that none of the parts drained are weakened by the drainage openings.

(d) Lubrication: All rotating and sliding parts shall be thoroughly cleaned and well lubicated during erection. All parts shall be properly lubricated before the operating machinery is tested. Counterweight and operating ropes shall be given one coat of an approved lubricant.

(e) Camber, General Requirements: When movable bridges are being erected, care shall be taken to set the camber blocking to the necessary heights, so that the span will be assembled to the proper camber curves when the structural parts are in the unstressed condition. When the camber blocking is struck and the spans swung, the rivets in all main truss connections shall have been driven or the joints 100 percent pinned and bolted so that no slip will occur at the connections.

(f) Camber for Swing Spans: When swing spans are erected upon camber blocking, the blocking shall be set to such elevation as to fulfill the following requirements:

1. When the blocking is removed and the span allowed to swing free under full dead load at normal temperature, the elevations at the span ends shall be at a distance below grade equal to the specified end lift.

2. When the wedges are fully driven and the structure is acting under full dead load including the desk, the elevation at all panel points shall conform to the specified grade lines.

It will be observed that the above method involves the superimposition of 2 cambers. The first is equal to the deflection of the structure as a cantilever under full dead load and the second is equal to the deflection when acting as a continuous or partially continuous span under full dead load and the dead load end reactions.

(g) Alignment of Bascule Leaves: The trusses or girders of a bascule span erected in an open position shall be held to correct alignment and position by means of struts, braces and guys. When required, the punching of laterals shall be left blank until the bridge is lowered so as to permit adjustment of the alignment to insure correct closing and locking.

(h) Alignment and Trunnion Bearings: Special care shall be taken in alignment of trunnion bearings by means of beveled shims or other means provided so that when full deflection of the trunnion girder or bearing

support occurs under full dead load, the axes of the trunnions will be coincident.

(i) Alignment of Vertical Lift Spans: Special care shall be taken to assure the proper spacing and aligning of the towers so that the towers and guides will be truly vertical when the dead load of the span and counterweight has been applied.

(j) Service Test of Machinery: A service test of the power operation of the span shall be made by moving the span through a number of complete open and close cycles. The number of cycles required will be determined by the engineer. These cycles of movement shall be executed in succession without intervals of rest between them, so that any tendency of the operating parts to become heated may be discovered. All defects found in the operation of the span shall be corrected.

809.40 COUNTERWEIGHTS. The counterweights shall be sufficient to balance the moving span and its attachments in any position, except that in vertical lift bridges the counterweight ropes shall not be balanced unless otherwise specified.

Counterweights shall be of concrete, supported in a steel box or by a steel frame. Unless otherwise provided, they shall be made adjustable so that variations in the weight of the movable span may be easily provided for. This shall be done by adding or taking off concrete or cast iron blocks in properly located pockets. Concrete blocks weighing not over 100 pounds each shall be used unless otherwise provided and they shall be provided with eye or ring bolts to facilitate handling. Space for 5 percent under and 5 percent above the calculated weight shall be provided. Movable blocks shall be provided as specified on the plans. The pockets shall be provided with drain holes not less than 6 inches in diameter. If the counterweights of bascule and vertical lift bridges are located above the floor of the approaches, the vertical clearance between the counterweights and the floor, curbs, sidewalks or handrails shall not be less than 2 feet and 6 inches when the bridge is in the fully open position. In calculating the minimum clearance, the counterweight ropes shall be assumed to stretch 2 percent of their calculated length.

Concrete for counterweight and adjusting blocks shall be Class A, weighing approximately 145 pounds per cubic foot, unless otherwise specified. Steel punchings or scrap metal may be used when necessary to increase the concrete unit weight. If clean steel punchings are used, they shall be placed in layers and grouted with a cement mortar composed of one part portland cement and 2 parts sand. The maximum available total weight shall not be taken as more than 315 pounds per cubic foot. Such a mixture shall not be used as a counterweight which revolves above a horizontal axis, unless retained in place by a surrounding steel box or by walls of reinforced concrete.

The fabricator of the structural steel shall determine the weight and where it is necessary, the location of the center of gravity of the moving span, in-

cluding all parts attached thereto, and of the counterweights, including their frames. These determinations shall be based on weights carefully computed from approved shop plans and these weights shall include the structural steel, machinery, flooring and everything attached to the movable parts of the bridge. The adjustment pocket of the counterweights is to be assumed ½ full when determining the size of counterweights. The contractor shall submit to the Bridge Design Engineer for approval, the calculations for determining the weight of the concrete for counterweights.

The determination of the proper mixture for the counterweights in order to give the desired unit weight is especially important and a series of tests shall be made well in advance of the time that placing of the concrete is to begin to determine the unit weight of the concrete which can be obtained from the materials at hand. Test blocks containing not less than one cubic foot shall be made and a record kept showing the weight of the blocks when cast and when 1, 2, 3 and 7 days old. The engineer shall be notified at least 3 days prior to casting of test blocks, and the casting and weighing of the blocks shall be done in the presence of the engineer or his authorized representative. This record of test blocks must be submitted to the engineer for approval before concreting is to begin and these tests shall be made by the contractor in time to have the information available for the fabricator by the time the latter is ready to detail the counterweights.

The unit weight of materials entering into the construction of the floor deck is an important factor in the determination of the volume of the counterweights and the contractor shall furnish the engineer and fabricator with the unit weight of the materials used in the floor. The determination of the unit weights shall be made by actually weighing samples of these materials. If the floor is of concrete, test blocks shall be made as outlined above to determine the unit weight of the floor slab as constructed.

The contractor shall assume full responsibility for the correctness of the center of gravity calculations. He shall also be responsible, where necessary, for the detail drawings of the counterweights and the construction of the counterweights of correct unit weight so that the bridge, when completed, will be in proper balance. The contractor shall be fully responsible for the balancing of the bridge and shall make free of charge, all necessary adjustments and alterations which may be required to obtain a proper balance.

If the contractor sublets the fabrication, such subletting will not relieve him from the full responsibility for the correctness of the counterweight calculations and all other required work, whether performed by him or his subcontractors. This, however, shall not relieve the subcontractor of any responsibility which he may have under his contract with the contractor.

809.41 POWER PLANT.

(a) General: This item shall be as provided in current AASHTO Standard Specifications for Design of Movable Bridges, and as specified in the

plans and project specifications except as provided herein.

(b) **Power Supply:** On electrically operated bridges, the contractor shall make all necessary arrangements with the power company for electrical service. The contractor shall furnish and install the service pole and shall bring the electrical power service to the switchboard in the operating house. Unless otherwise provided, the electrical service shall be 110/220 volts, 4 wire delta, 3 phase, 60 Hertz A.C. and shall be brought into the operating house underground in rigid metal conduit.

No direct payment or additional allowance will be made for the power used in the operation of the movable span while testing and adjusting or for power used while instructing the permanent bridge operators or for power used for any other reason while the bridge is being completed prior to final inspection. The cost of power consumed before the final acceptance by the Department shall be included in the lump sum bid under Item 809(3).

(c) **Inspection of Switchboard and Control Desk:** Before shipment, the control desk and switchboard shall be tested for operation sequence of devices, grounds and ability to withstand operating voltages and currents in accordance with NEMA standards. The contractor shall give the engineer ample notice before making final tests so that the engineer may arrange to have an observer present to inspect the switchboard and control desk and to witness these tests. Witnessing of the tests or not shall be at the option of the Department and shall in no way relieve the contractor of any responsibility placed upon him by his contract.

(d) **Grounding and Bonding:** The entire system shall be grounded and bonded in accordance with the National Electric Code (NEC). All conduit runs shall be bonded at the control desk and switchboard as well as throughout the system.

(e) **Wiring:** Unless otherwise provided, all conductors shall be copper and have a rated 600 volt moisture and heat resistant NEC Designation Type XHHW, XLPE insulation, and shall conform to Subsection 1017.10.

All conductors, except spares, shall be terminated on high pressure connector barrier type terminal blocks. All conductors shall be identified with adhesive type wire markers, with the proper identification stamped thereon.

Conductors smaller than AWG No. 12 shall not be used. All conductors shall be stranded in accordance with IPCEA specifications.

(f) **Conduit:** The entire conduit system shall be rigid metal conduit, except that a short length of flexible conduit shall be provided at the connections to motors, brakes, limit switches and other equipment as shown on the plans. All underground conduit and conduit embedded in concrete, shall be hot-dipped galvanized, sherardized or metallized rigid steel con-

duit. All conduit exposed on structures shall be rigid aluminum. All conduit fittings shall be cast aluminum, with cast covers and solid neoprene gaskets. All conduit clamps, clamp backs and nest backs shall be heavy duty malleable iron, hot-dip galvanized, and shall be held with stainless steel hexagon head bolts, with hexagon nuts and external tooth lockwashers. Insulated throat metal bushings shall be used at the ends of all conduits to prevent injury to the conductors. One-eighth inch drain holes shall be drilled at the low point of all conduit runs before wire is pulled in the conduit. Cut threads on steel conduit shall be given an approved protective coating before assembly. Threads on aluminum conduit shall be painted with an approved oxide inhibiting compound. Material used in the manufacture of conduit shall be in accordance with Subsection 1017.09.

Stainless steel hardware shall be in accordance with Subsection 1017.08.

(g) Junction Boxes: Junction boxes shall be made of welded aluminum plate, with a minimum wall thickness of ¼ inch. All corners and edges shall be well rounded and all welds shall be ground smooth. Junction boxes shall have drain and breather fittings, located top and bottom.

Junction boxes shall have sufficient terminal blocks to terminate all conductors except spares. Mounting terminal blocks on the sides, top or bottom of the boxes will not be permitted. A clear distance of at least 6 inches shall be provided between rows of terminal blocks and not less than 6 inches between terminal blocks and the sides of the box. The minimum depth of the junction box shall be twice the diameter of the largest conduit entering the box plus 2 inches, but in no case less than 6 inches. Junction boxes shall have hinged covers, equipped with neoprene gaskets to form watertight seals, and held closed with stainless steel hinged bolts with winged nuts.

Cast aluminum hubs shall be used for conduit attachment to the junction box.

All hardware used to attach hubs or terminal blocks to the box and all other hardware shall be stainless steel.

Materials used in the fabrication of these boxes shall be in accordance with Subsection 1017.11.

Hardware shall be in accordance with Subsection 1017.08.

(h) Terminal Blocks: Terminal blocks shall be provided for the termination of all conductors, except spares, which do not terminate at devices equipped with terminals. Terminal blocks shall be of the barrier type equipped with high pressure connectors. Black over white plastic marking strips shall be provided and each connector shall be identified by engraving the marking strip with the same identification as the elementary wiring diagram.

(i) Internal Combustion Engines: Internal combustion engines shall

be as shown on the plans.

(j) Fuel Tank: Fuel tanks shall be a minimum of 100 gallon capacity and constructed of steel sheet metal not less than ⅛ inch thick. Approved fiberglass tanks may be used underground. The tank shall be labeled by the Underwriters Laboratory and shall be equipped with drain, vent and filler pipes. The filler pipe shall be so constructed as to permit gaging of the tank with a calibrated stick gage to be furnished by the contractor.

809.42 OPERATING HOUSE. The operating house shall be constructed in accordance with the plans. All obviously necessary parts or fittings not specifically shown or specified shall be furnished by the contractor without extra charge.

809.43 MACHINERY HOUSES. Machinery houses shall be constructed in accordance with the plans. All obviously necessary parts or fittings not shown or specified shall be furnished by the contractor without extra charge.

809.44 METHOD OF MEASUREMENT.

(a) Movable Bridge Machinery: Movable bridge machinery will be measured by the lump and the measurement shall include all gears, including gears for operating limit switches, shafts, couplings, bearings, castings, wedges, wedge bases, latches, speed reducers, lubricating system, center pivots, racks and tracks for swing spans, bearing discs, balance wheels, trunnions and trunnion bearings, pins, sleeves, sheaves, wire ropes and their sockets and socket pins, bolts, screws, bolts and nuts connecting machinery parts to structural steel, castings which form an integral part of the machinery, winding drums, tread plates and castings for segmental girders and track girders for rolling lift spans and their connecting bolts, pistons and cylinders, eccentrics, pinions, ring gears, racks, clutches, brakes other than electrical brakes, rollers, valves, locks, toggles, crank arms, cranks, axles, hooks, bearing liners, wrenches, springs, manually operated roadway traffic gates, mechanically operated position indicators and all other similar parts and fittings necessary for the satisfactory operation of the bridge which require machine shop work and which are not included in any other class, and all items which are classified as "Movable Bridge Machinery" on the plans.

(b) Traffic Barriers: Traffic barriers will be measured by the lump. This item shall consist of furnishing all materials and erecting the traffic barriers in accordance with the plan details and project specifications.

(c) Power Plant: Power plant will be measured by the lump and the measurement shall include all electrical motors, internal combustion engines and all incidental parts, electrical generator sets, electrically operated brakes, switchboard and control desk with their attachments and electrical parts, controllers, resistors, limit switches, transformers, cir-

cuit breakers, electric navigation lights, navigation and sound signals, storage batteries, battery chargers, electrically operated position indicators, service lighting, traffic warning signals, electrically operated roadway traffic gates, flood lights, wiring, conduits and their fittings, junction boxes, submarine cables, flexible cables, collector rings, contactors, switches, instructors, pit pumps, name plates for each operating element, and all other items and equipment required for the installation of a complete power plant and all items which are classified as "Power Plant" on the plans.

(d) **Operating House:** The operating house will be measured by the lump and the measurements shall include all obviously necessary parts of the house, including furniture and cabinets. If the house is supported on piling, the piling will be measured as provided in Section 804.

(e) **Machinery Houses:** Machinery houses will be measured by the lump and the measurement shall include all obviously necessary parts of the houses.

(f) **Class A concrete** in counterweights will be measured by the cubic yard in accordance with Subsection 805.17.

Deformed reinforcing steel or structural steel used in counterweights will be measured as provided in Sections 806 and 807.

809.45 BASIS OF PAYMENT. Machinery, traffic barriers, power plant, operating house and machinery houses will be paid for at the respective lump sum contract prices complete in place and accepted.

Concrete and reinforcing steel or structural steel used in counterweights will be paid for as provided in Section 805, 806 and 807.

Payment will be made under:

Item No.	Pay Item	Pay Unit
809(1)	Movable Bridge Machinery	Lump
809(2)	Traffic Barriers	Lump
809(3)	Power Plant	Lump
809(4)	Operating House	Lump
809(5)	Machinery Houses	Lump

Section 810

Bridge Railings and Barriers

810.01 DESCRIPTION. This work consists of furnishing all materials and constructing bridge railings and barriers of the type specified in accordance with these specifications and in reasonably close conformity to the lines, grades and dimensions shown on the plans or established by the engineer.

810.02 MATERIALS. All materials used in the construction of bridge railings and barriers shall conform to Section 1012. All concrete used in barriers, railings and posts shall be Class AA conforming to Section 901.

810.03 CONSTRUCTION, FABRICATION, ERECTION AND PAINTING. All construction, fabrication, erection and painting shall conform to Sections 805, 806, 807 and 811 as modified herein.

Slip-formed concrete will be permitted, subject to the following provisions. The sliding forms shall be rigidly held together to prevent spreading of forms, and after passing there shall be no noticeable slumping of concrete. The concrete shall be held at a uniform consistency, having a slump of ½'' to 1½'' unless otherwise approved by the engineer. The contractor's proposed slip-forming procedures and equipment shall be approved by the engineer prior to beginning slip-form concrete placement. If, in the opinion of the engineer, the slip-forming operation fails to produce satisfactory results, the contractor shall immediately discontinue slip-forming operations, shall replace or satisfactorily repair the unacceptable concrete, and shall complete the work using conventional forming methods.

810.04 LINE AND GRADE. The line and grade of the railing or barrier shall be true to that shown on the plans and shall not follow any unevenness in the superstructure. Unless otherwise specified or shown on the plans, the barrier, railing and curbs on bridges, whether superelevated or not, shall be normal to cross slope and grade.

810.05 EXPANSION JOINTS. Expansion joints shall be so constructed as to permit freedom of movement. After all work is completed, all loose or thin shells or mortar likely to spall under movement shall be removed.

810.06 PLACING RAILING. In no case shall concrete barrier or railing be placed until centering of falsework for the span has been released,

rendering the span self-supporting. On continuous spans, railing or barriers shall not be placed until the entire deck of the continuous unit is completed.

810.07 METAL RAILING. Metal railing shall be carefully adjusted prior to fixing in place to insure proper matching at abutting joints and correct alignment and camber throughout its length. Holes for field connections shall be drilled with the railing in place on the structure at proper grade and alignment.

810.08 METHOD OF MEASUREMENT. The quantities of railings and barriers for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities of railing include all work constructed above the roadway curb, sidewalk or sidewalk curb; and design quantities of barriers include all work constructed above the roadway.

810.09 BASIS OF PAYMENT. The accepted quantities of railing and barriers will be paid for at the contract unit price per linear foot, subject to the following provisions.

Reinforcing steel and hardware required for railings and barriers will be considered as incidental to the work and will not be paid for separately.

Concrete railing will be paid for on a lot basis. A lot will be a completed unit or an identifiable pour that is completed in one day.

Two random batches shall be sampled for each lot, and 3 cylinders molded for each batch. The 6 specimens per lot will be tested for compressive strength in 28 to 31 days. In the event of sudden cessation of operations, a minimum of 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be in accordance with Schedule A of Subsection 901.14.

Payment will be made under:

Item No.	Pay Item	Pay Unit
810(1)	Concrete Railing (Type)	Linear Foot
810(2)	Steel Railing	Linear Foot
810(3)	Steel Channel Railing	Linear Foot
810(4)	Pipe Railing	Linear Foot
810(5)	Steel and Concrete Railing	Linear Foot
810(6)	Pipe and Concrete Railing	Linear Foot

Section 811

Painting and Protective Coatings

811.01 DESCRIPTION. This work consists of the painting of all items specified and shall include the preparation of surfaces, the application, protection and drying of the paint coating in accordance with the plan, project specifications and as directed by the engineer.

Unless otherwise specified, an approved 2-coat paint system consisting of an organic base primer and its respective gray topcoat shall be used for painting metal surfaces in accordance with these specifications. The contractor shall notify in writing the Department's Bridge Design Engineer and the Consulting Engineer, if one is involved, of the approved paint system that will be used on the project prior to submitting required shop drawings. This paint system must be shown on all shop or working drawings.

General requirements for the galvanizing and metallizing of metal surfaces are also included in this section.

811.02 SAFETY STANDARDS. The contractor's attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. Appropriate respiratory protective devices must be provided by the contractor and must be used. Respiratory equipment, including hood type respirator with external air supply to hood, shall meet the approval of the U.S. Bureau of Mines.

811.03 MATERIALS.

(a) The Organic Zinc Primer and Topcoat Systems shall conform to Subsection 1008.02 and shall be one of the approved systems on the Department's Qualified Products List. The contractor has the option of using any one of these systems; however, no modification or combining of systems will be permitted and the same system shall be used throughout the project. Color of the topcoat shall match color samples that are available upon request from the Department's Materials Section.

(b) The Basic Lead Silico Chromate Paint System shall conform to subsection 1008.04. Colors of the several coats shall be in accordance with standard color samples that are available upon request from the Department's Materials Section.

(c) The Red Lead and Aluminum Paint System shall conform to Subsection 1008.05 and 1008.07.

811.04 PAINTING METAL. All metal surfaces, whether classified as structural steel, machinery, traffic barriers, power plant or otherwise, shall be painted with the 2-coat organic zinc primer and topcoat system, unless otherwise stated or unless painting would interfere with the proper operation of movable metal parts.

When field weld connections are required, the areas to be welded shall be masked before shop painting of members and painted after welding.

Controls desks and switchboards shall be painted as described on the plans. Equipment mounted on the control desks and switchboards shall not be painted unless otherwise specified.

All preassembled and precoated parts shall be treated with one coat of barrier primer conforming to Military Specification MIL-P-15328C at a dry film thickness of 1 mil (minimum) prior to application of the topcoat.

When required galvanized, sherardized or metallized surfaces of sheet metal, electrical conduit, water, air and gas pipes that are exposed and visible shall be painted. The surfaces that are to be painted shall be treated with one coat of barrier primer conforming to Military Specifications MIL-P-15328C at a dry film thickness of 1 mil (minimum) prior to application of the topcoat. All other galvanized, sherardized or metallized surfaces shall not be painted.

Metal surfaces to be encased in concrete shall not be painted.

Painting of aluminum surfaces will not be required unless otherwise specified.

(a) Organic Zinc Primer and Topcoat Systems: Coatings shall be applied in one application and the minimum dry film thickness of coatings shall be as follows.

1. Organic Zinc Primer	3.0 mils
2. Topcoat	3.0 mils

The minimum total dry film thickness of the 2-coat system shall be 6.0 mils.

(b) Basic Lead Silico Chromate System: The minimum dry film thickness of coatings shall be as follows.

1. First Coat (Brown)	1.5 mils
2. Second Coat (Maroon)	1.5 mils
3. Third Coat (Gray)	1.5 mils
4. Final Coat (Cement Gray)	1.0 mil

The minimum total dry film thickness of the 4-coat system shall be 5.5 mils.

(c) Red Lead and Aluminum System: The minimum dry film thickness of coatings shall be as follows.

1. First Coat (Red Lead)	1.5 mils

2. Second Coat (Red Lead with 1 oz of lampblack paste per gallon of paint)	1.5 mils
3. Third Coat (Red Lead)	1.5 mils
4. Final Coat (Aluminum)	1.0 mil

The minimum total dry film thickness of the 4-coat system shall be 5.5 mils.

811.05 WEATHER LIMITATIONS. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather with the relative humidity being below 85 percent. Painting will not be permitted when the atmospheric temperature is below 45°F or when it can be anticipated that the atmospheric temperature will drop below 45°F before the paint is dry through, except as provided in the following paragraph for enclosures. If fresh paint is damaged by the elements, it shall be replaced by the contractor at his expense.

Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

Subject to the approval of the engineer, in writing, the contractor may provide suitable enclosures to permit painting during inclement weather. Provisions shall be made to control atmospheric conditions artificially inside the enclosure within limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work requiring paint and no additional compensation will be allowed.

811.06 CLEANING OF SURFACES.

(a) General: Unless otherwise specified, all metal surfaces to be painted or coated shall be cleaned by blast cleaning in accordance with the Near-White Blast Cleaning Method.

All surfaces of a casting shall be blast cleaned before the casting is machined.

All structural steel to be encased in concrete shall be blast cleaned, hand tool cleaned or power tool cleaned.

All weld spatter and other undesirable materials shall be removed and sharp edges ground smooth for metal surfaces prior to blast cleaning.

The Steel Structures Painting Council Preparation Specifications are referred to throughout this Subsection and the contractor shall be cognizant of these requirements.

(b) Near-White Blast Cleaning Method: This method prepares metal surfaces for painting or coating by the use of abrasives propelled through nozzles or propelled by centrifugal wheels.

(1) Definition: The near-white cleaned surface finish is defined as

one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to the light discoloration mentioned above.

(2) **Procedures:** The Specifications for Near-White Cleaning shall be in accordance with the requirements of Specification SSPC-SP 10 with the following modifcations. The anchor pattern shall be 1 to 3 mils. The rate of blast cleaning may vary from one area to the next in order to achieve the desired pattern. The use of recycled shot blasting material will be permissible, provided anchor pattern requirements are met and adhesion is not compromised. All blast cleaned surfaces shall be painted before any rusting occurs, preferably within 8 hours after blasting. The occurrence of rusting after cleaning shall be sufficient cause for re-cleaning by blasting or other cleaning methods as directed by the engineer.

(3) **Safety Precautions:** Safety precautions shall be taken in accordance with the requirements of Specifications SSPC-SP 10.

(c) **Commercial Blast Cleaning Method:** This method prepares metal surfaces for painting or coating by the use of abrasives propelled through nozzles or propelled by centrifugal wheels.

(1) **Definition:** The commercial blast cleaned surface is defined as one from which all oil, grease, dirt, rust scale and foreign matter have been completely removed from the surface and all rust, mill scale and oil paint have been completely removed except for slight shadows, streaks or discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating that may remain; if the surface is pitted, slight residues of rust or paint may be found in the bottom of pits; at least two-thirds of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to the light discoloration, slight staining or tight residues mentioned above.

(2) **Procedures:** The procedures for Commercial Blast Cleaning shall be in accordance with Specifications SSPC-SP 6.

(3) **Safety Precautions:** Safety precautions shall be in accordance with Specifications SSPC-SP 6.

(d) **Pickling Method:** This method of cleaning structural steel shall not be used, unless otherwise specified.

(1) **Definition:** The pickling method prepares metal surfaces for painting by completely removing all mill scale, rust and rust-scale by

chemical reaction. The pickled surface shall be completed free of all scale, rust and foreign matter. Furthermore, the surface shall be free of unreacted or harmful acid or alkali or smut.

(2) Procedures: The procedures for Pickling shall be in accordance with the Specification SSPC-SP 8-63 with the following modifications.

The pickling shall be by chemical reaction methods as described in Sections 3.1.2.1, 3.1.2.2 and 3.1.2.3.

(3) Safety Precautions: Safety precautions shall be in accordance with Specifications SSPC-SP 8.

811.07 PROTECTION OF THE PUBLIC AND WORK. The contractor shall protect all parts of the work against disfigurement by spatters, splashes and smirches of paint or of paint materials. The contractor shall be responsible for any damage caused by his operations to vehicles, persons or property, including plants and animals; he shall provide protective measures at his expense to prevent such damage.

Paint stains which might result in an unsightly appearance shall be removed or obliterated by the contractor at his expense.

If traffic causes an objectionable amount of dust, the contractor shall, at his own expense, allay the dust for the necessary distance on each side of the work and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

811.08 MIXING OF PAINT. Except as otherwise specified under Section 1008, paint shall be premixed at the factory. Paint shall also be thoroughly field-mixed by hand or mechanically before applying and shall be stirred sufficiently while being used to keep the pigments in uniform suspension.

811.09 THINNING PAINT. Paint as delivered in containers, when thoroughly mixed, is ready for use. If it is necessary in cool weather to thin the paint in order that it shall spread more freely, this shall be done only by heating in hot water or on steam radiators and liquid shall not be added nor removed unless permitted.

811.10 APPLICATION.

(a) Organic Zinc Primer and Topcoat Systems: Primer and topcoat paint shall be applied with airless or conventional spray equipment. The spray equipment shall apply the paint in a fine and even spray without the addition of thinner, unless approved by the engineer. If thinning of paint is allowed, it shall be done in accordance with the paint manufacturer's recommendations. A moisture trap shall be placed between air supply and pressure pot, and regulators and gauges shall be provided for both air supply and pressure pot. The spray gun shall be held no closer than 6

inches or more than 10 inches from surfaces to be coated and at right angles to the surface. Fluid pressure shall be regulated to deliver a uniform and wet coat of material from the spray gun.

On all surfaces which are inaccessible to spray equipment, the paint shall be applied with brushes or approved daubers to insure coverage.

All film thickness measurements will be made with an approved dry film thickness tester. Measurement of the dry film thickness will be made by adjusting the approved measuring device to read 3 mils on a 3-mil shim placed on the blast surface. Since different readings will be obtained at various places, the devices will be adjusted so that the average reading for a particular section is 3 mils.

(1) **Color Contrast:** Primer coat shall be so tinted as to provide a color contrast from the blast cleaned metal and the topcoat. The coloring may be included in the zinc dust or the vehicle.

(2) **Primer:** Primer for new steel shall be applied after fabrication and before erection, and must be applied at the shop.

Potlife of the primer shall not exceed the limits specified by the manufacturer. When the limit is reached, the spray pot must be emptied, material discarded, and new material mixed.

All primer must be cured a minimum of 72 hours before application of the topcoat.

(3) **Field Spot Priming:** Damaged areas or other surfaces to be field primed shall be blast cleaned and painted with the approved organic zinc to a minimum dry film thickness of 3.0 mils. Surface preparation shall be the same as required under Subsection 811.06. The primer shall be allowed to cure 72 hours prior to application of the topcoat. These requirements for field touch-up priming shall apply to the applicable parts of Subsection 811.12.

(4) **Topcoat:** Topcoat paint for new steel may be applied either before or after erection.

Dust film or other residue shall be removed prior to painting to assure that the coating achieves a tight bond to the primer. The use of sandpaper for cleaning is acceptable, provided the minimum dry film thickness of primer remains.

Topcoat shall be applied at the specified minimum film thickness, as described in Subsection 811.04. Where members are inspected and found low in film thickness, the entire member shall be recoated to eliminate lap marks. The contractor shall exercise the necessary controls to elimate laps, sags, overspray patterns and other undesirable characteristics.

(b) **Basic Lead Silico Chromate System:** Basic lead silico chromate

paint shall be applied as airless spray, unless otherwise permitted in a neat and workmanlike manner.

The airless spray equipment shall apply the paint in a fine and even spray without the addition of any thinner. The coating of paint applied shall be smooth and uniform, producing no sags or runs, with no heavy deposit of the wet coat requiring excessive curing time.

On all surfaces which are inaccessible to the airless spray, the paint shall be applied with approved brushes or daubers to insure thorough coverage.

No portion of the paint films shall be less than the specified film thickness; however, the film thickness shall not be so great that either the appearance or service life of the paint will be detrimentally affected.

Not less than 72 hours shall elapse between applications of coats of paint for the basic lead silico chromate paint system.

(c) Red Lead and Aluminum System: Shop and field coats may be applied with hand brushes, rollers or sprayer or by a combination of these 3 methods of application. However, by any method, the coating of paint applied shall be smoothly and uniformly spread so that no excess paint will collect at any point. The right is reserved to require the use of hand brushing should the results of spraying be unsatisfactory.

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform and even coating in close contact with the metal or with previously applied paint and shall be well worked into all corners and crevices.

Power spraying equipment shall apply the paint in a fine and even spray without the addition of any thinner.

Paint applied with spray equipment shall immediately be followed by hand brushing, when necessary, to secure uniform coverage and to eliminate airholes, blistering, splotches or wrinkling.

No portion of the paint films shall be less than the specified film thickness; however the film thickness shall not be so great that either the appearance or service life of the paint will be detrimentally affected.

Not less than 72 hours shall elapse between applications of coats of paint for the red lead and aluminum paint system.

811.11 SHOP PAINTING.

(a) Surfaces to be Painted: When fabrication and cleaning are completed, surfaces not previously painted during assembly shall be painted with one coat of the approved or specified paint before any damage to the cleaned surface occurs from weather or other exposure. Shop contact surfaces shall not be painted unless otherwise specified. Surfaces to be in contact after field erection shall not be painted unless a coat of lacquer or other

protective coating is specified on the plans or fabrication details. Surfaces to be in contact with concrete shall not be painted. Where paint would be detrimental to field welding operations or field bolted splice areas, the surface shall not be shop painted within a suitable distance from the edges to be welded or spliced.

(b) Erection Marks: Erection marks shall be painted on painted surfaces with paint of contrasting color.

(c) Loading: Material shall not be loaded for shipment until the paint is dry.

(d) Inaccessible Surfaces: Surfaces not to be in contact but which will be inaccessible after erection shall receive the complete paint system prior to assembly or erection.

(e) Machine Finished Surfaces: With the exception of abutting chord and column splices, rocker shoes and bases and column and truss shoe bases, machine finished surfaces shall be coated with an approved protective material as soon as practicable after being accepted and before removal from the shop. Surfaces of iron and steel castings which are machine finished for the sole purpose of removing scales, fins, blisters or other surface deformations shall be given the shop coat of paint.

(f) Pins and Pin Holes: All pins and pin holes shall be given a coat of an approved protective coating. The protective coating shall be removed and replaced with a graphite coating prior to erection.

811.12 FIELD PAINTING. As soon as the field cleaning has been done to the satisfaction of the engineer, the heads of field rivets and bolts and any surfaces from which the shop coat of paint has been worn off or otherwise has become defective shall be covered with one coat of the same paint as was used in the shop. When the paint applied for touching up rivet or bolt heads and abraded surfaces has become dry, the first field coat may be applied. In no case shall a coat be applied until the previous coat has dried throughout the full thickness of the paint film.

Small cracks and cavities which have not been sealed in a watertight manner by the first field coat shall be filled.

No field coats of paint shall be applied to the steel work below the highway floor level until the concrete roadway slab has been completed and the metal work carefully cleaned. If concreting operations have damaged the paint, the surface shall be cleaned and spot painted as directed by the engineer.

811.13 SPECIAL STENCILING. The date (month and year) of painting and type of paint system used shall be stenciled at 2 locations on all bridge structures in block letters 2½ inches high. The exact locations will be determined by the engineer. The paint used shall form a distinct contrast with the background and shall be compatible with the paint system used.

811.14 PAINTING LUMBER AND TIMBER. Unless otherwise specified, all new lumber and timber requiring painting shall be cleaned to the satisfaction of the engineer and shall be painted with 3 coats of paint. The paint used shall be as specified in the plans or project specifications. If not shown or specified, the paint to be used will be selected by the engineer. Treated timber to be painted shall be processed in accordance with Subsection 1014.04(c).

When specified, timber railings shall be painted with 3 coats of white ready-mix paint meeting the requirements of Subsection 1008.06. Each coat shall have a minimum dry thickness of 1.5 mils.

All applicable requirements of this section shall apply to the painting of lumber and timber.

811.15 PAINTING GALVANIZED SURFACES. Galvanized surfaces shall be prepared for painting by applying an approved primer or by deferring the painting as long as possible to allow the surface to weather.

A barrier coat conforming to Military Specification MIL-P-15328C shall be applied to galvanized surfaces which require painting before application of the paint.

811.16 GALVANIZING OF METAL PARTS AND SURFACES.

General: The following listed criteria shall be properly controlled and shall meet standards that are satisfactory to the engineer for the galvanizing process:

1. Defects arising from fabrication
2. Thickness and uniformity of coating
3. Adherence of coating
4. Appearance
5. Embrittlement

The handling, stacking, transporting and erecting of the galvanized parts shall be done in such a manner as to protect the coating and coating appearance.

Galvanized parts shall be assembled with nonabrasive equipment.

Drip holes shall be plugged to the satisfaction of the engineer.

Galvanizing of products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips, ⅛ inch thick and heavier, shall conform to ASTM Designation: A 123. Galvanizing shall be performed after fabrication into the largest practicable sections. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, bending, welding and riveting. Components of bolted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.

Galvanizing of iron and steel hardware shall conform to ASTM Designation: A 123 and A 153, and when specified shall conform to the following quenching requirements. All parts that are hot-dip galvanized shall be quenched immediately after removal from the kettle. The quenching solution shall contain from 0.1 percent to 1 percent chromic acid by volume and shall be maintained at a temperature of 150°F to 160°F, with a maximum allowable temperature of 180°F. Galvanizing shall be performed after fabrication of the hardware. Components of bolted assemblies shall be galvanized separately before assembly.

Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be repaired by the application of a low temperature galvanizing repair compound, in the shape of a bar or rod, to the pre-heated 600°F repair surface. The bar or stick shall be rubbed over the pre-heated surface with the melted repair material being brushed over the bare area with a wire brush. The low temperature galvanizing repair compound shall be submitted for approval and shall be in accordance with Federal Specification 0-G-93, 29 November 1949. Zinc coating by the metallizing process may be allowed when approved by the engineer.

811.17 METALLIZING OF METAL PARTS AND SURFACES. When specified, metallizing shall be performed in accordance with the AWS Specification C 2.2 and the thickness of the sprayed zinc coat shall be a minimum of 5 mils. The method of applying the zinc coating shall be approved by the engineer prior to application.

811.18 METHOD OF MEASUREMENT. No measurement will be made for painting or any protective coating, unless specifically provided for in the contract.

811.19 BASIS OF PAYMENT. No direct payment will be made for painting of any of the structures or surfaces described above unless pay items for painting are included in the contract. The contract prices for the various structures and surfaces to be painted shall include the cost of furnishing all materials, labor, etc., to complete all painting or protective coating required in accordance with these specifications.

Section 812

Untreated and Treated Timber

812.01 DESCRIPTION. This work consists of furnishing lumber of the sizes and grade specified and of furnishing timber of the stress-grade, sizes and dimensions for the different uses specified, treated or untreated, and of preparing, framing, assembling and erecting the same, including painting where specified and all hardware required by the plans and specifications, all in accordance with these specifications and in conformity with the plan details.

812.02 MATERIALS. All materials shall conform to the following Subsections.

Structural Timber and Lumber	1014.01
Piling	1014.02
Preservatives	1014.03
Treatment	1014.04
Connectors	1017.07
Hardware and Structural Shapes	1017.08
Pitch	1017.13

812.03 SPECIES OF WOOD.

(a) Permanent Structures: Unless otherwise specified, all lumber and timber used in the construction of permanent bridges, bridge fenders, and bulkheads may be either Douglas Fir or Southern Pine, provided the same species shall be used throughout each structure, except in bridge structures as hereinafter provided.

Caps and stringers for any bridge structure may be either fir or pine regardless of the species used in the remainder of the structure; however, all caps and stringers furnished for any structure shall be the same species. Lumber and timber shall not be used in exposed structures without preservative treatment, unless otherwise specified.

(b) Temporary Structures: Temporary structures may be any species and grade of timber which is satisfactory for the intended purpose.

812.04 HARDWARE FOR TIMBER.

(a) Structural Shapes: Rods, plates and shapes shall be of structural

steel or wrought iron, as specified. Eyebars shall conform to the requirements for structural steel eyebars.

(b) Castings: Castings shall be cast steel or gray iron, as specified.

(c) Bolts, Dowels and Other Hardware: Machine bolts, drift-bolts and dowels may be either wrought iron or medium steel. Washers may be cast ogee or malleable castings or they may be cut from medium steel or wrought iron plate, as specified.

Machine bolts shall have square heads and nuts, unless otherwise specified. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes or boat spikes, as specified.

Nails, spikes, bolts, dowels, washers and lag screws shall be galvanized, unless otherwise specified.

Unless otherwise specified, all hardware, except malleable iron connectors, for treated timber bridges shall be galvanized.

812.05 STORAGE OF MATERIAL. Lumber and timber stored on the site shall be kept in orderly piles or stacks. Untreated material shall be open-stacked on supports at least 12 inches above the ground surface to avoid absorption of ground moisture and permit air circulation and it shall be so stacked and stripped as to permit free circulation of air between the tiers and courses. When directed, protection from the weather by suitable covering will be required.

On glued laminated structural members that are not to be preservatively treated, an approved end sealer shall be applied after end trimming of each completed member.

812.06 TREATED TIMBER. Treated timber shall be interpreted to mean timber of the specified species and stress grade treated as stipulated in Subsection 1014.04. The types of preservative permitted and the portions of structures where the types may be used shall be as specified.

(a) Workmanship: Workmanship shall be first class throughout. Only competent bridge carpenters shall be employed and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified for metal structures.

(b) Surfacing: All lumber and timber, except bulkhead planks and sway bracing, shall be surfaced on 4 sides (S4S), unless otherwise specified.

(c) Handling: Treated timber shall be carefully handled without dropping, breaking of outer fibers, bruising or penetrating the surface with

tools. It shall be handled with rope slings. Cant hooks, peaveys, pikes or hooks shall not be used.

(d) Framing and Boring: All cutting, framing and boring of treated timbers shall be done before treatment insofar as practicable. When treated timbers are to be placed in waters infested by marine borers, untreated cuts, borings or other joint framings below highwater elevation shall be avoided.

(e) Installation of Timber Connectors: Timber connectors shall be of the specified types. The split ring and the shear plate shall be installed in pre-cut grooves of dimensions as given herein or as recommended by the manufacturer. The toothed ring and the spike grid shall be forced into the contact surfaces of the timbers joined by means of pressure equipment. All connectors of this type at a joint shall be embedded simultaneously and uniformly. Fabrication of all structures using connectors shall be done prior to treatment. Bolt holes shall not be more than 1/16 inch larger than bolt diameter and shall be bored perpendicular to the face of the timber.

Timber, after fabrication, shall be stored in a manner which will prevent changes in the dimensions of the members before assembly.

Dimensions of material and details not otherwise specified shall meet with the approval of the engineer.

(f) Cuts and Abrasions: All cuts in creosoted piles or timbers and all abrasions, after having been carefully trimmed, shall be covered with 2 applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or brush-coated with at least 2 applications of hot creosote oil and covered with hot roofing pitch.

Cuts and abrasions in timbers treated with waterborne preservatives or pentachlorophenol shall be repaired with the same preservative.

(g) Bolt Holes: Holes bored in pressure-treated material shall be filled with preservative.

All unused bore holes and spike holes shall be poured full of preservative and plugged with tight-fitting, treated plugs.

(h) Temporary Attachment: Whenever, with the approval of the engineer, forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanied nails or spikes flush with the surface or plugged as required for bolt holes.

812.07 TREATMENT OF PILE HEADS.

(a) General: Pile heads, after cutting to receive the caps and prior to placing the caps, shall be treated to prevent decay. Pile heads to be encased in concrete will not require treatment.

Immediately after making final cut-off on treated timber foundation piles, the cut area shall be given two liberal applications of preservative followed

by a heavy application of coal-tar pitch or other approved sealer. The heads of treated timber piles in bents or where the cut-off is exposed shall be protected by one of the following methods, as specified on the plans. If not otherwise specified, galvanized metal coverings shall be used.

(b) Galvanized Metal Coverings: The sawn surface shall be thoroughly brush coated with 2 applications of hot creosote oil, after which there shall be placed 2 layers of heavy canvas (14 ounces minimum per square yard), size 20'' x 20'' saturated with hot asphalt, followed by 24'' x 24'' number 28 gage galvanized metal cover. The cover shall be bent down over the pile at an angle of approximately 45°.

(c) Fabric Covering: The heads of all treated piles shall be covered with alternate layers of hot pitch and loosely woven fabric similar to membrane waterproofing, using 4 applications of pitch and 3 layers of fabric. The cover shall measure at least 6 inches more in dimension than the diameter of the pile and shall be neatly folded down over the pile and secured by large headed galvanized nails or by binding with not less than 7 complete turns of galvanized wire securely held in place by large-headed galvanized nails and staples. The edges of the fabric projecting below the wire wrapping shall be trimmed to present a workmanlike appearance.

The heads of untreated piles shall be thoroughly brush coated with 2 applications of hot creosote oil.

812.08 HOLES FOR BOLTS, DOWELS, RODS AND LAG SCREWS. Holes for round drift-bolts and dowels shall be bored with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit the same diameter as the bolt, except as otherwise provided.

Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

812.09 BOLTS AND WASHERS. A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood. Stacked washers shall not be permitted and bolts shall not project more than one inch beyond the nut on work securely tightened. Long bolts shall be saw-cut or clipped, ground smooth and repaired as specified in Subsection 811.16.

The nuts of all bolts shall be effectually locked after they have been finally tightened.

812.10 COUNTERSINKING. Countersinking shall be done wherever

smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil and, after the bolt or screw is in place, shall be filled with hot pitch.

812.11 FRAMING. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. No shimming will be permitted in making joints nor will open joints be accepted. All mating pieces shall be tightly bound or clamped in position prior to drilling bolt holes.

812.12 PILE BENTS. Piles shall be driven as indicated on the plans and in accordance with Section 804.

812.13 FRAMED BENTS.

(a) Mud Sills: Timber mud sills shall be of heart cedar, heart cypress, heart redwood, treated southern pine, treated fir, or other durable timber. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

(b) Concrete Pedestals: Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than ¾ inch diameter and projecting at least 6 inches above the tops of the pedestals shall be set in them when they are cast for anchoring the sills or posts.

(c) Sills: Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than ¾ inch diameter and extending into the mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

(d) Posts: Posts shall be fastened to pedestals with dowels of not less than ¾ inch diameter, extending at least 6 inches into the post. Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

(1) By dowels of not less than ¾ inch diameter, extending at least 6 inches into posts and sills.

(2) By drift-bolts of not less than ¾ inch diameter driven diagonally through the base of the post and extending at least 9 inches into the sill.

(e) Design and Construction: Where framed structures will be subjected to earthquake, wind, or tractive or centrifugal loads, the connections between members thereof shall be so designed and constructed as to resist the forces resulting therefrom.

812.14 CAPS. Timber caps shall be placed, with ends aligned, in a manner to secure an even and uniform bearing over the tops of the supporting posts or piles. All caps shall be secured by drift-bolts of not less than ¾ inch diameter extending at least 9 inches into the posts or piles. The drift-bolts

shall be approximately in the center of the post or pile.

812.15 BRACING. The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than ⅝ inch diameter. Intermediate intersections shall be bolted or spiked with wire or boat spikes as indicated on the plans. In all cases, spikes shall be used in addition to bolts.

812.16 STRINGERS. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least ½ inch for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are 2 panels in length, the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least 2 nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified, cross-bridging shall be placed at the center of each span.

812.17 PLANK FLOORS. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The planks shall be laid heart side down, with ¼ inch openings between them for seasoned material and with light joints for unseasoned material. Each plank shall be securely spiked to each joist. The planks shall be carefully graded as to thickness and so laid that no 2 adjacent planks vary in thickness by more than 1/16 inch.

Two-ply timber floors shall consist of 2 layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with creosote oil. The top course may be laid either diagonal or parallel to the centerline of roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least 3 feet. If the top course is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge, these members shall be beveled.

812.18 LAMINATED OR STRIP FLOORS. The strips shall be of the grade specified and shall be placed on edge at right angles to the centerline of roadway. Each strip shall be spiked to the preceding strip at each end and at approximately 18-inch intervals, with the spikes driven alternately near the top and bottom edges. The spikes shall be of sufficient length to pass through 2 strips and at least half-way through the third strip.

If timber supports are used, every other strip shall be toe-nailed to every other support. The size of the spikes shall be as shown on the plans. When specified on the plans, the strips shall be securely attached to steel supports

by the use of approved galvanized metal clips. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on all the supports.

812.19 COMPOSITE WOOD-CONCRETE DECKS.

(a) Slab Spans: Where the tensile strength of wood and the compressive strength of concrete are to be used compositely, the joining of the 2 materials shall be such as to resist all horizontal shear at that plane and provision shall be made to prevent separation of the materials.

The horizontal shear may be resisted by metal devices set into and projecting above the top of the laminated strips or by fabricating the upper edge of the strips in a serrated manner.

Separation of the materials may be resisted by nails driven at an angle in the upper edge of the strips or by suitable devices or by grooves or other working of upstanding strips.

(b) "T" Beams: Spans consisting of concrete slabs placed on wood stringers may be designed as "T" beams when the 2 materials are suitably joined so as to resist horizontal shear at their juncture and the materials are bonded permanently together.

A horizontal shear joint may be made using metal devices or by serrating the tops of the stringers.

Separation of the concrete from the stringers may be prevented by driving nails in the top of the stringers at an angle or by other suitable metal devices or by grooving the sides of the stringers near the top or other working of the wood and then forming the concrete into the patterns worked in the wood.

812.20 WHEEL GUARDS AND RAILING. Wheel guards and railing shall be accurately framed in accordance with the plans and erected true to line and grade.

Wheel guards shall be laid in sections not less than 12 feet long.

812.21 TRUSSES. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and, in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately.

812.22 TRUSS HOUSING AND RAILINGS. Unless otherwise directed, housing and railings shall be built after removal of falsework and adjustment of the trusses to correct alignment and camber. Workmen wearing shoes with cleats will not be permitted on the roof.

812.23 PAINTING. Parts of the structure which are to be painted will be designated in the plans or project specifications.

Metal parts not galvanized shall be painted in accordance with Section 811.

Where timber decks are provided, the top flanges of all stringers and floor beams shall be protected by a covering composed of a heavy layer of asphaltic material (tar, asphalt or pitch) applied hot and one thickness of 2-ply tar paper wide enough to project 3 inches beyond the edges of the members. These edges shall be bent down at an angle of approximately 45°.

812.24 METHOD OF MEASUREMENT. The quantities of timber for payment will be the design quantities and adjustments thereto. The design quantities are based on the number of thousand board feet of timber in the completed work. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary. Hardware will not be measured for payment, but will be considered as incidental to the work. Metal parts not classified on the plans as hardware will be measured and paid for in accordance with Section 807.

812.25 BASIS OF PAYMENT. The accepted quantities of timber will be paid for at the contract unit price per thousand board feet.

Payment will be made under:

Item No.	Pay Item	Pay Unit
812(1)	Untreated Timber	MFBM
812(2)	Treated Timber	MFBM

Section 813

Concrete Approach Slabs

813.01 DESCRIPTION. This work consists of the construction of concrete approach slabs for bridges and other structures, in accordance with the details and at the locations and of the dimensions shown on the plans.

813.02 MATERIALS. Materials shall conform to the following Sections and Subsections.

Portland Cement Concrete	901
Deformed Reinforcing Steel	1009.01
Joint Materials	1005

813.03 CONCRETE. Concrete for pile-supported approach slabs shall be Class AA. Concrete for all other approach slabs, and bolster blocks under approach slabs, shall be Class A or one of the concrete pavement types of Section 901. The slabs shall be constructed in accordance with Sections 601 and 805.

Curing shall be in accordance with Subsection 601.12. Surface tolerances shall meet the requirements for jointed pavement of Subsection 601.13.

813.04 REINFORCING STEEL. Reinforcing steel shall be placed in accordance with Section 806.

813.05 BEARING PILES. When shown in the plans, the approach slab shall be supported on bearing piles. The piling shall be driven at the locations shown on the plans and in accordance with Section 804.

813.06 BOLSTER BLOCKS. Bolster blocks, when required, shall be constructed in accordance with these specifications and as indicated on the plans. The contractor shall place 3 layers of approved tar paper or 1 coat of paint or heavy grease between the bolster block and the pavement slab and expansion joint adjacent to the approach slab.

813.07 ROADWAY FINISH. The roadway shall be given a metal tine texture finish. All surface finishing operations shall be performed in accordance with Subsection 601.11.

813.08 RELIEF JOINTS. Relief joints of premolded joint filler or poured filler shall be constructed in accordance with the plan details.

813.09 SUBGRADE. When required by the plans, the approach slab

subgrade shall consist of aggregate material placed in accordance with plan details. Aggregate material shall be either dead clam shell containing not more than 10 percent foreign matter (by dry weight), or washed gravel or crushed stone conforming to Subsection 1003.05. The aggregate shall be placed and compacted as directed and covered with approved polyethylene film of at least 6-mil thickness.

813.10 METHOD OF MEASUREMENT. The quantities of concrete approach slabs for payment will be the design areas as specified on the plans and adjustments thereto. Design quantites will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. The design quantities are based on the horizontal dimensions shown on the plans. All required reinforcing steel, bearing piles, concrete bolster blocks, joint materials, aggregate subgrade materials and polyethylene film will be considered incidental to the work and will not be measured for separate payment.

813.11 BASIS OF PAYMENT. The accepted quantities of concrete approach slabs will be paid for at the contract unit price per square yard, subject to the following provisions.

Acceptance and payment for concrete approach slabs will be made on a lot basis. A lot will be considered as a complete approach slab or an identifiable pour that is completed in one day. Concrete in bolster blocks will be considered minor structure concrete. Two random batches will be sampled for each lot, and 3 cylinders molded for each batch. The 6 cylinders per lot will be tested for compressive strength in 28 to 31 days. In the event of sudden cessation of operations, a minimum of 3 cylinders will constitute a lot. Acceptance and payment for each lot will be made in accordance with Schedule A of Subsection 901.14. If one of the Types of pavement concrete is used, the price adjustments as specified for Class A concrete will be applied.

Payment will be made under:

Item No.	Pay Item	Pay Unit
813(1)	Concrete Approach Slabs	Square Yard
813(2)	Concrete Approach Slabs (Pile Supported)	Square Yard

Section 814

Drilled Shaft Foundations

814.01 DESCRIPTION. This work consists of the construction of foundations of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when the shafts are without bell type footings and in drilled and under-reamed excavation when shafts are with bell type footings. Such foundations shall be constructed in accordance with the plan details and these specifications.

814.02 MATERIALS. All concrete shall be Class D conforming to Sections 805 and 901.

Reinforcing steel shall conform to Section 806. The sizes and dimensions shall be as shown on the plans.

814.03 CONSTRUCTION REQUIREMENTS.

(a) Excavation: The contractor shall perform all excavation required for the shafts and bell footings, through whatever substances encountered and to the dimensions and elevations shown on the plans or required by the site conditions. Unless otherwise shown on the plans, all shafts shall be bored plumb to a tolerance of 1½ inches for depths up to and including 10 feet plus an additional tolerance of 0.05 inch per foot for depths in excess of the first 10 feet. The center of the drilled shaft at the top shall lie within a 3-inch diameter circle with the center of that circle being the theoretical center of the drilled shaft. When bells are required, they shall be excavated so as to form a bearing area of the size and shape shown on the plans. Shafts and bells may be excavated either by hand or by mechanical methods. Blasting methods shall be used only with permission of the engineer and when used shall be so conducted as to avoid disturbance of the formations below or outside the limits of the proposed shaft concrete.

The plans indicate the expected depths and elevations at which satisfactory bearing material will be encountered and this information will be used as a basis for the contract. If satisfactory foundation materials are not encountered at plan elevations, the footings may be raised or lowered as determined by the engineer.

Casings will be required for shaft excavations when necessary to prevent caving of the material or to shut off seepage water. Casings shall be of

metal and of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials and shall be watertight. The inside diameter of casing shall not be less than the nominal size of shaft; otherwise, the size of casing and the size of drilled excavation in which the casing is to be placed will be left to the discretion of the contractor, except as noted below. No extra compensation will be allowed for the concrete required to fill an oversize casing or oversize excavation.

When the drilling operation reaches a point where caving conditions or excess ground water is encountered, no further drilling will be allowed until a construction method is employed which will prevent any caving that tends to make the excavation appreciably larger than the size of casing to be used. Drilling in a mud slurry without removal of cuttings or other construction methods which will control the size of excavation will be permitted. The contractor will be required to use a method of construction which will allow completion of the top of the drilled shaft without any intermixing of concrete and drilling mud.

If the elevation of the top of shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of the shaft will be required to control caving of any material into the freshly placed concrete.

Any excavation for the footing bells or shafts beyond the lines required by the plan dimensions, where casings are not required, shall be backfilled with Class D concrete at the contractor's expense. Where casings are used, the contractor will be permitted to backfill around the upper portion of the casing with pea gravel or other granular material. Where a double casing is required for a portion of the shaft, no material shall be placed between the casings, but this area shall be filled with Class D concrete.

Under normal operations when the casing is to be removed, the removal shall not be started until all concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches or rotating of the casing to insure the breaking of bond of the concrete to the casing will be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. A sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the pull shall be in a vertical direction. If any upward movement of the concrete or steel inside the casing occurs at any time during the pulling operation, the following criteria shall govern:

(1) If the upward movement is one inch or less, the casing may be left in place and the shaft used if the concrete is vibrated or rodded to reconsolidate the concrete. Vibration or rodding shall not be used to attempt to break the casing loose for extraction unless the entire shaft is to be replaced.

(2) If the upward movement is greater than one inch, all of the material shall be removed and the entire drilled shaft operation shall be redone.

Drilled shaft concrete shall not be placed under water without permission of the engineer. If such permission is granted, underwater concrete shall be placed in accordance with Subsection 805.06 and limited to placement with a tremie.

Material excavated from shafts and bells and not used in the backfill around the completed bents or piers shall be disposed of as directed. The disposal of such material shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base area. The contractor shall provide suitable access and lighting for the engineer to inspect the completed foundation excavation and check the dimensions and alignment of drilled shafts and the under-reamed excavation when under-reaming is required.

At any time when a person is in the hole, provisions shall be made for pumping fresh air to the workman. Any required lighting shall be by electric lights. Any mechanical equipment used in the excavation shall be operated by air or electricity. The use of gasoline driven engines placed in the excavation for pumping or drilling will not be permitted.

In order that the engineer may judge the adequacy of the proposed foundation, the contractor, if requested, shall make soundings or take cores at his expense to determine the character of the supporting materials. The depth of such soundings or cores will not be required to exceed 5 feet below the proposed footing grade.

When the plans require drilled shafts in the end bents, the embankment at the bridge ends shall be made to grade as shown and thoroughly compacted as provided in the governing specifications prior to drilling for end bent shafts.

(b) Reinforcing Steel: The reinforcing steel cage for the shaft consisting of longitudinal bars and spiral hooping or lateral ties shall be completely assembled and placed into the shaft as a unit. Generally, the reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

The longitudinal bars shall be tied or tack-welded to the spiral hooping at intervals not to exceed 12 inches on centers to provide a rigid unit.

For cased shafts where the reinforcing steel cage is over 30 feet in length, the longitudinal bars shall be tied or tack-welded at each intersection of the spiral hooping for a distance of L/5 from the bottom of the cage, where L is the length of the spiral cage.

The cage of reinforcing steel shall be supported from the top by some positive method to prevent slumping downward during extraction of the casing. Dowel bars in the top of the shaft which are not tied together with a cage may be inserted immediately after the completion of the placing of concrete.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts concrete spacer blocks shall not be used. Metal chair type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

(c) **Concrete:** The work shall be performed in accordance with Section 805 and the requirements herein.

Preferably, concrete shall be placed immediately after all excavation is complete and reinforcing steel placed.

Concrete placing shall be continuous from the beginning of placing in the shaft or footing bell to the top of shaft or to construction joint as may be indicated on the plans. Time intervals will be allowed for pulling casings, for placing forms and other operations necessarily carried on in sequence with the placing operations. The reinforcing steel cage shall be held vertical in some manner to restrain the steel from slumping during the concrete placement operation.

Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on the reinforcing steel cage. The tube shall be made in sections to permit the discharge and raising as the placement progresses.

Wherever a casing is used, the casing shall be smooth and well oiled and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal. Where a casing is to be pulled, the concrete placed in casing shall be of such workability as to require no vibrating or rodding.

Where a cap block or groundline strut is shown on the plans to be placed at the top of the drilled shaft and the cap or strut is shown to be monolithic with the drilled shaft, a time interval will be allowed for placing the required form and reinforcing after any necessary casing removal. When the drilled shaft is continued by means of a column, the contractor must make provisions for adequately holding the column form at the top of the drilled shafts either by means of inserts or by forming and pouring a stub the size of the column.

After a concrete pour is completed, the top surface shall be cured and any construction joint area shall be treated as specified in Section 805.

814.04 TEST HOLES. When shown on the plans or when ordered by the engineer in writing, test holes will be required to establish elevations for

"belling" to determine elevation of ground water or to determine soil characteristics.

The diameter and depth of test hole or holes shall be as shown on the plans or as directed by the engineer.

814.05 TEST BELLS. When shown on the plans or when ordered by the engineer in writing, under-reaming of bells on specified test holes will be required to establish the ability to under-ream in the soil strata present.

The diameter and shape of the test bell shall be as shown on the plans or as directed by the engineer.

814.06 METHOD OF MEASUREMENT. Acceptable drilled shafts in place of the specified diameter will be measured by the linear foot. At interior bents and piers, shafts will be measured from a point 6 inches below the ground elevation at the center of shaft after clearing operations are completed unless otherwise indicated on the plans. At highway grade separations and at railroad underpasses, the ground elevation will be the completed roadway section under the structure. At stream crossings and at railroad overpasses, the ground elevation will be the elevation existing at the time drilling begins. At abutment bents the length of shaft will be measured from the bottom of cap elevation.

Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the engineer, will be measured by the cubic yard of concrete in the acceptable footings placed. The bell shall consist of the authorized footing volume outside the dimensions of the drilled shaft, which for the purpose of measurement will be considered as extending to the bottom of the bell.

Test holes of the specified diameter will be measured from the elevation of the ground at the time drilling begins by linear foot of acceptable test hole drilled.

Test bells of the specified diameter and shape will be measured by each test bell acceptably under-reamed.

814.07 BASIS OF PAYMENT. The accepted quantities of drilled shafts will be paid for at the contract unit price per linear foot, subject to the following limitations for overruns authorized by the engineer.

(a) Payment for individual completed shaft lengths up to and including 5 feet in excess of the maximum plan length shaft as defined herein will be made at the contract unit price per linear foot.

(b) Payment for that portion of individual completed shaft length in excess of 5 feet and up to and including 15 feet more than the maximum plan length shaft, as defined herein will be made at a unit price equal to 115 percent of the contract unit price per linear foot.

(c) Payment for individual completed shaft lengths over 15 feet in excess

of the maximum plan length shafts as defined herein will be in accordance with Subsection 109.04.

(d) For extra depth drilling the maximum plan length shaft will be considered to be maximum length shaft.

Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the engineer, will be paid for at the contract unit price per cubic yard. Payment for authorized increases in footing bell diameters beyond 3 times the nominal shaft diameter will be made in accordance with Subsection 109.04.

Test holes of the specified diameter will be paid for at the contract unit price per linear foot.

Test bells of the specified diameter will be paid for at the contract unit price per each.

Test holes or test bells required by the engineer but not otherwise specified by the plans will be paid for in accordance with Subsection 109.04.

The foregoing unit prices shall be full compensation for making all excavations, for drilling all test holes and test bells, doing any necessary pumping, placing and removing any required casings, furnishing and placing all concrete and reinforcing steel except as noted below and all backfilling. Where the bottom of drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, payment will be made at the contract unit price per pound for "Reinforcing Steel" for the extra reinforcement required to make one 20-diameter lap splice per bar. No extra payment will be made for casings left in place.

Payment will be made under:

Item No.	Pay Item	Pay Unit
814(1)	Drilled Shaft (Diameter)	Linear Foot
814(2)	Bell Footing	Cubic Yard
814(3)	Test Hole (Diameter)	Linear Foot
814(4)	Test Bell (Diameter)	Each

Section 815

Welding

815.01 DESCRIPTION. Welding of structural steel, steel pipe and aluminum alloys, and qualification of procedures, welders and welding operators and destructive and nondestructive testing shall be in accordance with the requirements of these specifications and the DOTD Welding Procedures Manual.

815.02 QUALIFICATION OF PROCEDURES, WELDERS AND WELDING OPERATORS.

(a) General:

(1) The Department's Construction Section shall be the sole qualifying agency.

(2) Qualifying tests may be made at locations selected by the contractor, but advance notice of not less than one week shall be given to the Construction Section so that the Department can arrange for the presence of the inspector.

(3) Seven copies of the required reports will be furnished to the Construction Section. If requested, the Department will furnish the necessary forms.

(4) Each welder and welding operator's work shall be identified with a steel stencil.

(5) The social security number of each qualifying welder and welding operator shall be furnished and recorded on the required reports, and the qualified welder shall have his social security card in his possession when working.

(6) All costs incidental to welding qualifications shall be the responsibility of the contractor.

(b) Steel:

(1) Welding procedures shall conform to the requirements of the DOTD Welding Procedures Manual.

(2) Welders and welding operators shall be qualified in accordance with the requirements of the DOTD Welding Procedures Manual.

(c) Aluminum: Welding qualifications for aluminum alloys shall conform to the requirements of the DOTD Welding Procedures Manual.

(d) Steel Pipe: Welding qualifications for steel pipe shall conform to the requirements of the American Society of Mechanical Engineers Code, Section IX. as modified by the DOTD Welding Procedures Manual.

(e) Electrodes: All electrodes shall be qualifed in accordance with the DOTD Welding Procedures Manual.

815.03 WELDING OF STRUCTURAL STEEL. Welding of structural steel shall conform to the DOTD Welding Procedures Manual.

815.04 WELDING OF ALUMINUM ALLOYS. Welding of aluminum alloys shall conform to the DOTD Welding Procedures Manual.

815.05 MEASUREMENT AND PAYMENT. There will be no direct payment for radiographic inspection, magnetic particle inspection, dye penetrant inspection or other tests as specified. All costs therefor are to be included in the unit price bid on pay items.

The size, type and length of the welds shall be as shown on the plans.

There will be no measurement or payment made for any weld metal deposited; however, there will be no deduction made for the metal to be welded due to edge preparation.

PART IX

PORTLAND CEMENT CONCRETE

Section 901

Portland Cement Concrete

901.01 GENERAL. This Section specifies the requirements for all classes and types of concrete, and includes methods and equipment for handling and storing of the materials and the mixing and transporting of the concrete to the site.

Portland cement concrete shall be composed of a mixture of portland cement, fine aggregate, coarse aggregate and water and, when specified or allowed by the specifications, shall include approved admixtures.

All concrete plants furnishing portland cement concrete, except concrete for minor structures in accordance with Section 902, shall be certified by the Department and the design, control and transportation of concrete mixtures shall be the responsibility of the contractor in accordance with these specifications.

All required laboratory facilities at portland cement concrete plants shall be furnished by the contractor. These facilities will be considered as incidental to the work and will not be paid for directly.

901.02 MATERIALS. Materials shall conform to the following Subsections.

Portland Cement	1001.02
Masonry Cement	1001.04
Fine Aggregate	1003.01, 1003,02
Coarse Aggregate	1003.01, 1003.03
Admixtures	1011.02
Water	1017.01

Coarse and fine aggregates for use in concrete that will be subject to wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any materials that are deleteriously reactive with the alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts, the aggregate may be used with a cement containing less than 0.6 percent alkalies calculated as sodium oxide and potassium oxide.

901.03 TRANSPORTATION AND STORAGE OF CEMENT. All cement shall be transported in watertight conveyances and stored in water-

tight buildings, silos or other approved facilities in such a manner that the cement will be protected from dampness or water intrusion at all times. Cement which has become contaminated, partially set or which contains lumps of caked cement will be rejected. Cement from discarded or used bags shall not be used.

On small jobs, open storage of bagged cement may be permitted when approved in writing, in which case a raised platform and ample waterproof covering shall be provided.

The cement shall be certified by the manufacturer in accordance with the Department's current procedure. If non-certified cement is proposed for use, storage buildings or silos shall be provided with a capacity for the storage of a sufficient quantity of cement to allow sampling at least 12 days before the cement is to be used. Stored cement shall meet the test requirements at any time after storage when a retest is ordered.

The contractor shall keep accurate records of the deliveries of cement and of its use in the work. Copies of these records shall be supplied to the engineer in such form as may be required.

Different brands or types of cement, or the same brand or type of cement from different mills, shall not be mixed during use nor shall they be used alternately unless authorized by the engineer. This requirement can be waived in the case of a concrete plant breakdown during a pour in order to allow concrete to be furnished from another plant to finish pour in progress.

901.04 CARE AND STORAGE OF CONCRETE AGGREGATES. The equipment and methods used for stockpiling aggregates shall be such that no detrimental degradation or segregation of the aggregate will result and that no appreciable amount of foreign material will be incorporated into the aggregate and that there will be no intermingling of stockpiled materials.

When specified, the coarse aggregate shall be separated into 2 or more sizes in order to secure greater uniformity of the concrete mixture. Different grades of aggregates shall be stored in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed. Aggregates of the same grade, regardless of source, whose specific gravities vary by not more than 0.03 may be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods and washed aggregates shall be stockpiled or binned for adequate drainage. Transport containers will be accepted as adequate binning when adequate drainage is provided. Drainage of all aggregates shall meet the approval of the engineer prior to batching.

901.05 QUALITY CONTROL OF CONCRETE. In all portland cement concrete production, the contractor will assume full responsibility for the quality control of all materials during the handling, blending, mixing, and pouring operations. The contractor will assume responsibility for the initial determination and all necessary subsequent adjustments in proportioning of the materials used to produce the specified concrete. The contractor will have suitable equipment for the determination of aggregate gradation, moisture, air content, slump and temperature.

All concrete furnished to the Department, with the exception of concrete for minor structures, shall be from a certified plant. A qualified Concrete Batcher shall perform all batching operations. A qualified Concrete Technician shall be present at the plant, or the job site, whenever the plant is in operation. The Concrete Technician shall design concrete mixes, make adjustments in batch weights for moisture content, and perform all necessary adjustments in the proportioning of materials used to produce the specified concrete and perform all tests necessary for control of the concrete mix within the requirements of the specifications. If a Concrete Technician is not available at the job site, a qualified Concrete Tester (Field) will be allowed to perform the control tests for slump and air content and report the results to the Concrete Technician. The use of a Concrete Tester (Field) will not relieve the Concrete Technician from performing the remaining duties as outlined in these specifications.

The Department's inspector will never assume, by act or word, the responsibility of testing and analysis of the mix for control purposes, or the setting of dials, gages, scales or meters. Such duties are the responsibility of the contractor.

(a) Mix Design: The contractor shall submit in writing, for approval, his intended source of all component materials and his mix design for concrete he proposes to furnish on a form provided by the Department. No work shall be started, nor any concrete mix accepted, until the mix design has been approved by the Department. A mix design using approved aggregates may be approved at the plant at the time it is ready to start production on a project provided 24 hours notice is given to the Project Engineer. When unusual material conditions necessitate tests on trial mixes, such testing shall be performed at the Department's Materials Laboratory and shall require 45 days.

The gradation, unit weight, and specific gravity of aggregate intended for use may be determined by the Department if requested by the contractor.

Mix proportions shall be such as to produce concrete within the specified slump range.

(b) Control Tests: The contractor will be responsible for determining the gradation of fine and coarse aggregate used in the concrete mixture and for testing the concrete mixture for slump, air content and temperature

(when required). He shall conduct his operation so as to produce a mix conforming to the approved mix design, except that variations shall be permitted within specified control limits for individual samples. Results shall be charted on control charts for individual samples.

Slump and air content testing shall be performed by the lot as defined for pavement concrete in Subsection 601.21 and for structural concrete in Subsection 805.18.

For pavement concrete, each lot shall be divided into five equal portions, and one sample representing each portion shall be obtained randomly and tested for slump and air content, when required.

For structural concrete, each lot shall be represented by a minimum of two individual tests.

The contractor shall conduct a minimum of two gradation tests per day of fine and coarse aggregate for pavement concrete and one test per lot for structural concrete. In the event of an all day pour, one of the samples shall represent the morning control and the other the afternoon control. The times at which to obtain these samples shall be set by the contractor using random number tables in accordance with DOTD Designation: S 605 or by random selection. The control limits are as shown in the Master Proportion Table.

When the tendency of the individual slump, air content or gradation measurements, as plotted on the control charts, indicates that the mix will fall outside the tolerance limit, the contractor will make adjustments to bring the mix within the specified limits.

If the contractor should fail to make proper adjustments, or if the mix is obviously defective, the mix will be rejected by the Department prior to placing.

If it is found necessary to make adjustments in the basic mix design to obtain the desired workability, such changes in mix proportions shall be made provided the water-cement ratio is not exceeded, the minimum cement factor is obtained, and prior notification is given to the engineer.

No changes in the source or characteristics of the materials shall be made until such materials and new proportions have been approved.

901.06 CLASSES AND TYPES OF CONCRETE. Structural concrete is designated by class and pavement concrete by type. Each class or type concrete shall be used where called for on the plans or in the specifications.

901.07 COMPOSITION OF CONCRETE. The type of cement and composition of concrete shall be in accordance with the requirements of this Subsection and the table entitled "Master Proportion Table" unless otherwise stated on the plans or in the project specifications.

(a) Cement and Aggregates: Either Type I(B) or Type II cement shall

be used in general construction, including paving and structural concrete, except as otherwise stated in this Subsection or in the project specifications. Either Type I, Type I(B) or Type II cement shall be used in concrete in (1) minor structures, (2) prestressed or precast concrete work and (3) base course treatment or stabilization. Type III cement may be used for prestressed or precast concrete at the contractor's option and in other concrete mixtures when specified. The contractor may vary, without charge, the ratio of fine to coarse aggregate as approved by the engineer, but in no case shall it be varied so as to affect materially the unit volume of cement per unit volume of concrete as determined by the original proportions designed to obtain a cement factor of not less than that specified in the Master Proportion Table.

The specified cement contents indicated in the table are the minimum permitted, but are not assured by the Department since the cement content required for any mix is dependent upon the gradation of aggregates within the limits of the specifications for that particular gradation. The cement content is based upon the ideal combination and gradation of both fine and coarse aggregates.

(b) Admixtures: Admixtures shall be dispensed in a liquid state with the mixing water, and the method of dispensing shall be with an approved mechanical dispensing device. A separate dispensing device shall be provided for each admixture. All admixtures shall conform to the requirements of the specifications.

An air-entraining admixture will be required in concrete used for paving when a central mixing plant or a slip form paver is used.

Air-entraining admixture and a water-reducing admixture, normal set or set-retarding, will be required in all Class AA or AA(M) concrete.

The use of admixtures in other classes or types of concrete will be optional with the contractor unless otherwise specified. If the contractor desires to use an air-entraining admixture and/or a water-reducing admixture, normal set or set-retarding, it will be at his own expense without reducing the cement content, and approval must be obtained from the engineer in writing.

When an air-entraining admixture is required or permitted, the total air content of the concrete mix, when tested in accordance with DOTD Designation: TR 202, shall be as specified in the Master Proportion Table.

When an air-entraining admixture is used in combination with a water-reducing admixture, normal set or set-retarding, the two materials must be manufactured by the same company and must be compatible with each other.

When the atmospheric temperature in the shade and away from artificial heat is above 70°F, the water-reducing admixture shall be of the set-retard-

ing type; when the atmospheric temperature as described above is 70°F or below, the water-reducing admixture shall be of the normal set type. This requirement shall govern regardless of whether an admixture is required by the specifications or permission is requested by the contractor to use an admixture. The set-retarding admixture shall be used in an amount sufficient to produce the degree of retardation that is necessary for the particular pour being made. However, in no case shall the amount used be less than would be necessary to conform to all requirements of Subsection 1011.02.

(c) Water: The maximum amount of water permitted in relation to the cement content, including admixtures and free water for the mixture, shall not exceed the quantity specified in the Master Proportion Table. Free water shall include all water entering the mix with the aggregate except the water absorbed by the aggregate.

Because of the absorptive nature of lightweight aggregate and the inability to obtain a true saturated surface dry condition for determining free moisture, a maximum amount of water cannot be specified for Class X concrete. The consistency requirement will be the governing factor in determining the maximum allowable water.

(d) Coarse Aggregate: Coarse aggregate shall be of the grade specified in the Master Proportion Table and described in detail under Subsection 1003.03.

(e) Consistency: The composition of the mixture shall be such as to produce concrete of suitable workability with not less than the specified cement content and not more than the amount of water specified.

The consistency of the mixture shall be such as to have slumps within the ranges shown in the Master Proportion Table when tested in accordance with DOTD Designation: TR 207. These slump ranges represent the desirable limits of slump; however, the engineer may authorize an increase in the maximum limits when necessary for the construction of walls and diaphragms up to 8 inches in thickness, as long as the water-cement ratio is not exceeded.

(f) Compressive Strength:

(1) Structural Concrete: Class concrete mixes will be formulated with the intent of producing concrete which, when molded and cured in accordance with DOTD Designation: TR 226 and tested as prescribed in DOTD Designation: TR 230 shall show an average compressive strength in pounds per square inch as shown in the Master Proportion Table.

Cylinders by which the strength of Class P and Class P(M) concrete is to be determined shall be cured by the same methods used in curing the members they represent.

If the strength required for the class of concrete being produced is not

MASTER PROPORTION TABLE

Class or Type of Concrete	Average Compressive Strength psi at 28 days	Grade of Coarse Aggregate	Minimum Bags of Cement of 94 lbs. each to one Cu. Yd. of Concrete	Maximum Water per Sack of Cement (a) (Gallons)	Air Entrainment Total Air Content (percent by volume) (d)	Slump Range (Inches)		
						Non-Vibrated Placing	Vibrated Placing	Slip form Paving Placing (b)
Structural Class								
AA(M)	4,400	A	6.5	6.0	5 ± 1	2-5	2-4	N.A.
AA	4,200	A	6.5	6.0	5 ± 1	2-5	2-4	N.A.
A(M)	4,400	A	6.0	6.0	5 ± 2	2-5	2-4	N.A.
A	3,800	A	6.0	6.0	5 ± 2	2-5	2-4	1-2.5
D	3,300	A, B or D	5.0	6.6	5 ± 2	2-5	1-3	N.A.
P(M)	6,000(e)	A	7.0	5.0	5 ± 2	N.A.	2-6(g)	N.A.
P	5,000(e)	A	6.5	5.0	5 ± 2	N.A.	2-6(g)	N.A.
R	2,000	A, B or D	4.0	8.0	5 ± 2	2-5	1-3	N.A.
S	3,800	A	7.0	6.0	5 ± 2	6-8	N.A.	N.A.
X	3,800	Y	6.5	(c)	6-9	N.A.	1-3	N.A.
Pavement Type								
B	4,000(f)	B	5.8	6.0	5 ± 2	N.A.	2-4	1-2.5
C	4,000(f)	B (Crushed Slag)	6.0	6.0	5 ± 2	N.A.	2-4	1-2.5
D	4,000(f)	D	5.4	6.0	5 ± 2	N.A.	2-4	1-2.5
E	4,000(f)	E	5.0	6.5	5 ± 2	N.A.	2-4	1-2.5

N.A. — Not Applicable

(a) The maximum water-cement ratio (gal./sack) shall be reduced 5 percent when a water reducing admixture is used, and 10 percent when an air-entraining admixture, or air-entraining and water-reducing admixtures, is used.

(b) Also slump range for other concrete placed by extruded methods.

(c) Refer to Heading (c), Water, of Subsection 901.07.

(d) Total air content ranges when air entrainment is allowed or specified.

(e) Minimum compressive strength required.

(f) Average compressive strength for Pavement Type concrete shall be 3,600 psi when air entrainment is used.

(g) No more than a 2 inch slump differential for any designated pour.

secured with the minimum cement content specified, additional cement shall be used or other aggregate provided at the contractor's expense.

From the concrete being placed, the engineer may require such additional samples as necessary for compression tests to determine that the mix proportions being used produce the required strength.

(2) **Pavement Concrete:** The compressive strength of type concrete, and Class A concrete when used for pavement, will be determined from hardened concrete cores taken in place and tested in accordance with DOTD Designation: TR 225, and will meet the requirements given in the Master Proportion Table.

901.08 SAMPLING AND TESTING. All sampling and testing will be done in accordance with the Department's Materials Sampling and Testing Procedures Manuals and accepted procedures.

901.09 TEST SPECIMENS. The contractor shall furnish at his expense all necessary concrete for testing and/or casting beams and cylinders.

901.10 HANDLING MATERIALS. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work.

When mixing is at the site of the work, materials shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer with chute, boot or other approved device to minimize loss of cement and arranged to provide positive assurance of the actual presence in each batch of the cement content specified.

Bulk cement shall be transported to the mixer in tight compartments carrying the full amount of cement required for the batch or between the fine and coarse aggregate. Cement in original shipping packages may be transported on top of the aggregates, each batch containing the number of bags required by the job mix.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped into the mixer with minimum loss of cement, and when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.

901.11 BATCHING PLANT AND EQUIPMENT.

(a) General: The batching plant shall include storage bins, weighing hoppers and scales. The fine aggregate and each size, if more than one, of

coarse aggregate shall be weighed on scales, separately or cumulatively, in the weighing hopper from separate bins. If cement is used in bulk, a separate bin and scales system shall be used. The equipment shall be properly scaled and vented to eliminate as much dusting as possible.

The batching plant may be equipped to proportion materials by approved automatic weighing devices.

(b) Bins and Hoppers: Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided so that, as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. The weighing hopper shall be constructed so as to eliminate accumulation of materials and to discharge completely. Suitable provisions shall be made for the removal of overload from the hopper by the operator.

(c) Measuring Devices: Materials shall be measured by weighing except as otherwise specified or where other methods are specifically authorized by the engineer.

Scales shall be accurate to 0.5 percent throughout the range of use. The minimum graduation on the scales shall not exceed 0.1 percent of the rated capacity of the scales. When beam type scales are used, poises shall be designed to be locked in any position to prevent accidental change of position and the weigh beam and a "tell-tale" device shall be in full view of the operator. All measuring devices shall be subject to approval by the engineer.

Scales shall be tested, inspected and sealed by a qualified independent scale service at no cost to the Department as often as the engineer may deem necessary to assure their continued accuracy.

Individual aggregates shall be batched within ± 2 percent, and the total weight of the aggregate shall be within ± 1 percent of the required weight.

The cement, as weighed, shall be within $\pm$ 1 percent of the required weight. Cement in standard packages (sacks) need not be weighed; however, when sack cement is used, the quantities of aggregates for each batch shall be exactly sufficient for 1 or more full sacks of cement and no batch requiring fractional sacks of cement shall be permitted. The mixing water shall be measured by volume or weight. The water measuring device shall be accurate to $\pm$ 1 percent at one-half the maximum allowable water per batch.

When volumetric measurements are authorized for projects where the amount of concrete is small, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall

be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregate.

Methods and equipment for adding air-entraining agents or other admixtures into the batch shall be approved by the engineer. The quantity of admixtures shall be measured into the mixer with an accuracy of ± 3 percent.

(d) Recording of Batching (Ticket Printer System): Certified concrete plants may be equipped with an approved automatic ticket printer system for recording of required batching information. If the automatic ticket printer system is not used, quantities and batching information will be determined by visual observation, recorded and certified correct by the plant's Concrete Batcher or Concrete Technician.

The approved ticket printer system shall be "tamper-proof" and shall print the time of batching, water content, batch weights, moisture content of aggregate and quantities of admixtures, if used. The moisture content of aggregate or quantities of admixtures may be added to the printed ticket by the Concrete Batcher when the automatic system does not have these capabilities. During a breakdown period, the quantities will be determined by visual observation and certified as stated above.

Additionally, all records of batches shall show the batch number, the day, month, year and time of day to the nearest minute for each batch so each batch may be permanently identified. The maximum quantity of water that can be added at the job site shall be shown on the batch ticket. The Department shall be provided with a clear and legible copy of all batch records.

901.12 MIXING AND TRANSPORTING CONCRETE.

(a) General: Mixing operation shall begin within 30 minutes after the cement has been added to the aggregate. When cement is charged into a mixer drum containing surface-wet aggregate and when the ambient temperature is above 90°F, or when high early strength portland cement is used, this limit shall be reduced to 15 minutes.

(b) Mixing at Site: Concrete shall be thoroughly mixed in a batch mixer of an approved size and type which will insure a uniform distribution of the materials throughout the mass.

The mixer shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the amount of water used in each batch. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period.

The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein. The materials composing a batch shall be deposited simultaneously in the mixer except that a

portion of the mixing water shall enter in advance of the cement and aggregates. No mixer having a rated capacity of less than a one cubic yard batch shall be used nor shall a mixer be charged in excess of its rated capacity.

Concrete shall be mixed for a period of not less than 50 seconds. Mixing time shall begin after all materials, including water, are in the mixer. Mixing time ends when the discharge chute opens. During the period of mixing, the mixer shall be operated at a drum speed for which it has been designed as shown on the manufacturer's name plate on the approved mixer.

Should mixing operations be interrupted, the mixer shall be thoroughly cleaned.

The pick-up and throw-over blades or mixing paddles in the mixing drum or mixing unit shall be replaced when worn beyond the limit recommended by the manufacturer. The contractor shall have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth.

(c) **Truck Mixing:** Truck mixers, unless otherwise authorized, shall be of the revolving drum type, watertight and so constructed that the concrete can be mixed to insure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured in accordance with Subsection 901.11 and charged into the drum at the proportioning plant. Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed in the tank unless the tank is equipped with a device by which the quantity of water added can be readily verified. Truck mixers shall be equipped with electrically or mechanically actuated revolution counters in satisfactory working order by which the number of revolutions of the drum or blades may be verified. The counters shall be so located as to provide safe and convenient inspection. The delivery ticket will show the amount of water added.

Each truck mixer shall have attached thereto in a prominent place a metal plate (or plates) on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum in terms of the volume of concrete and the speed of rotation of the mixing drum or blades for both agitating and mixing speeds.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of mixer as stated by the manufacturer and stamped on a metal plate on the mixer. The minimum size batch allowed shall not be less than 1 cubic yard. When a truck mixer is used for complete mixing, each batch shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated as mixing speed by the manufacturer of the equipment on the metal plate on the mixer. Additional mixing, if any, shall be at the speed designated by the manufacturer of the

equipment as agitating speed. All materials, including mixing water, shall be in the mixer drum before actuating the revolution counter for determination of the number of revolutions of mixing.

When the prescribed water is added at the batching plant and the slump is on the low side at the delivery site, it will be permissible to add a minimum of 75 percent of the mixing water at the time the cement and aggregates are added at the batching plant and the remaining mixing water at the job site, provided additional mixing is performed at the job site to insure thorough incorporation of the added water into the mix. The truck mixer shall be equipped with means of accurately measuring the amount of water used in each batch. The additional mixing shall be within the range of 20 to 30 revolutions at mixing speed. Water added at the job site shall not exceed the water-cement ratio.

(d) Partial Mixing at the Central Plant: When a truck mixer or an agitator provided with adequate mixing blades is used for transportation, the mixing time at the stationary machine mixer may be reduced to 30 seconds and the mixing completed in a truck mixer or agitator. The mixing time in the truck mixer or agitator equipped with adequate mixing blades shall be as specified for truck mixing.

(e) Plant Mix: Mixing at a central plant shall conform to the requirements of mixing at the site.

(f) Transit Mix: When a batching plant is provided for exclusive use on the project and job conditions permit, on written request by the contractor, the engineer may approve mixing in transit.

(g) Time of Hauling and Placing Mixed Concrete: Wet batches of concrete may be transported in a truck mixer, agitator or other approved transportation equipment. Nonagitator trucks may be allowed when air entrainment admixture is used. The maximum volume of mixed concrete transported in an agitator and the speed of agitation shall be in accordance with the manufacturer's specified rating. Bodies of nonagitating hauling equipment shall be smooth, mortartight, metal containers and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when needed for protection.

When agitator trucks are used, the elapsed time between the addition of cement to the mix and depositing the concrete in place shall not exceed 90 minutes. When hauling is done in nonagitator trucks, such elapsed time shall not exceed 45 minutes. When dry batching of cement and aggregates is used, the elapsed time shall not exceed 90 minutes from the time cement comes in contact with aggregates until depositing the concrete mixture in place. In hot weather or under other conditions contributing to quick stiffening of the concrete, the maximum allowable time may be reduced by the engineer.

(h) Hand Mixing: When hand mixing is authorized, it shall be done on a watertight platform and in such a manner as to insure a uniform distribution of the materials throughout the mass. Mixing shall be continued until a homogeneous mixture of the required consistency is obtained.

(i) Delivery: The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete and to maintain a live workable surface. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum of rehandling and without damage to the structure or the concrete.

(j) Retempering: The concrete shall be mixed only in such quantities as are required for immediate use and any material which has developed initial set shall not be used.

901.13 LIMITATIONS OF MIXING.

(a) General: No concrete shall be mixed, placed or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is provided.

Air temperature shall be determined at the point of pour.

(b) Hot Weather Limitations: Unless otherwise specified, the hot weather limitations will only apply to structural concrete that is used in the decks of bridges.

Hot weather concreting practices will be considered when the job site temperature is 80°F and rising. When the internal temperature of the plastic concrete reaches 85°F, the contractor shall prevent the temperature of the succeeding batches from going beyond the 90°F upper limit by approved methods. If determined necessary, forms shall be precooled by approved methods immediately prior to the placement of concrete.

(c) Cold Weather Limitations: Unless authorized in writing by the engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F, and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials.

If the air temperature is 35°F or less at the time of placing concrete, the engineer may require the water or the aggregates to be heated to not less

than 70°F nor more than 150°F. No concrete shall be placed on a frozen subgrade nor shall frozen aggregates be used in the concrete.

901.14 ACCEPTANCE AND PAYMENT SCHEDULE. This acceptance and payment schedule will apply to all portland cement concrete that is poured in place other than portland cement concrete pavement. The portland cement concrete pavement acceptance and payment schedules are contained in Section 601.

This schedule does not apply for precast or precast-prestressed units and acceptance will be in accordance with current specifications for these units.

Acceptance and payment schedules are as follows:

Schedule A

STRUCTURAL CONCRETE

Average Compressive Strength per Lot, psi (28 to 31 days)

Class A(a)(c)	Class AA(c)	Class A(M)or Class AA(M)(c)	Class D(c)	Class S(c)	Percent Contract Price (c)
3800 & above	4200 & above	4400 & above	3300 & above	3800 & above	100
3400 - 3799	3800 - 4199	4000 - 4399	3000 - 3299	3400 - 3799	98
3000 - 3399	3200 - 3799	3600 - 3999	2500 - 2999	3000 - 3399	90
below 3000	below 3200	below 3600	below 2500	below 3000	50 or remove and replace (b)

(a) Use these values when "Type" concrete is used in approach slab items.

(b) When the average compressive strength of any batch in a lot is less than 3600 psi for Class A(M) or AA(M), less than 3200 psi for Class AA, less than 3000 psi for Class A and Class S, and less than 2500 psi for Class D, an investigation will be made. If concrete is allowed to remain in place, payment will be made as based on the average compressive strength for the lot. If the concrete is not found suitable to remain in place, the identifiable deficient areas shall be removed and replaced.

When the average compressive strength for a lot is less than 3600 psi for Class A(M) or AA(M), less than 3200 psi for Class AA, less than 3000 psi for Class A and Class S, and less than 2500 psi for Class D, an investigation will be made. If concrete is allowed to remain in place, payment for the lot will be based on 50 percent of the contract price.

When cores are obtained in these investigations, all values obtained from these cores will be used for evaluation purposes only and payment will be made based on the original acceptance samples.

(c) When structural concrete is incidental to an item or not a direct pay item, lot sizes, sampling and acceptance testing for the actual required quantities shall be in accordance with Subsection 805.18. The value for

each cubic yard required shall be assessed at 80 dollars for the purpose of applying the price adjustment percentages in Schedule A. The amount of the price adjustment for the quantity of concrete involved will be deducted from payment as required.

Section 902

Portland Cement Concrete for Minor Structures

902.01 GENERAL. The requirements for the mix design, inspection and testing of portland cement concrete in minor structures shall be in accordance with this section.

Concrete furnished under these specifications may be furnished from a certified or non-certified plant.

The following structures will be considered as minor structures and portland cement concrete for these structures will be classified as minor structure concrete:

1. Manholes, inlets, junction boxes and catch basins.
2. Curbs, gutters and sidewalks.
3. Paved ditches, revetments and medians.
4. Headwalls.
5. Embedment concrete for posts.
6. Foundation concrete for light standards and sign structures.
7. Cattle guards.
8. Other structures designated by the engineer, except bridges, box culverts and portland cement concrete pavement.

902.02 MIX DESIGN, INSPECTION AND TESTING.

(a) Mix Design: The contractor will not be required to submit mix designs to the engineer for approval unless the total quantity of each specified class of concrete for the project exceeds 50 cubic yards; however, complete records of the mixes being used shall be maintained by the contractor and made available to the engineer at all times. All concrete shall conform to the minimum requirements of Section 901 for the specified class. Compressive strength requirements shall be in accordance with Schedule B of Subsection 902.03.

(b) Inspection and Testing: Inspection and sampling of concrete will be performed at the point of delivery. The contractor will be responsible for proper batching, mixing and transporting of concrete. All concrete obviously improperly batched, mixed or transported will be rejected. Concrete of each specified class will be test sampled by molding sets of 3 cylinders in accordance with the following schedule, with a minimum of

one set per project per class of concrete. Additional cylinders may be molded at the engineer's discretion.

Cubic Yards per Day	Sets of Cylinders
More than 50	1 per 50 cubic yards
10 to 50	1 per day
Less than 10	1 per 50 cubic yards

902.03 ACCEPTANCE AND PAYMENT SCHEDULE. This acceptance and payment schedule will apply to all portland cement concrete placed as minor structure concrete. The amount of price adjustment for the quantity of concrete involved will be deducted from payment as required.

SCHEDULE B

MINOR STRUCTURE CONCRETE

Average Compressive Strength, psi (28 to 31 days)		
Class A	**Class R**	**Percent Contract Price (b)**
3,000 & above	2,000 & above	100
2,500 - 2,999	1,750 - 1,999	95
2,000 - 2,499	1,500 - 1,749	80
under 2,000	under 1,500	50 or remove and replace (a)

(a) When the average compressive strength is less than 2,000 psi for Class A and 1,500 psi for Class R, an investigation will be made. If concrete is allowed to remain in place, payment will be based on 50 percent of the contract price.

When cores are obtained in these investigations, all values obtained from these cores will be used for evaluation purposes only and payment will be made based on the original acceptance samples.

(b) When minor structure concrete is incidental to an item or not a direct pay item, sampling and acceptance testing for the actual required quantities shall be in accordance with this Section. The value for each cubic yard of concrete required shall be assessed at 80 dollars for the purpose of applying the price adjustment percentages in Schedule B. The amount of the price adjustment for the quantity of concrete involved will be deducted from payment as required.

PART X

MATERIALS

PART X

MATERIALS

PREFACE

Unless otherwise stated in these specifications or on the plans or in the project specifications, all sampling methods and testing methods shall be in accordance with the following documents; precedence shall be in the order as written:

FIRST — Louisiana Department of Transportation and Development (DOTD) Materials Sampling Manual and Testing Procedures Manual.

SECOND — Standards published by the American Association of State Highway and Transportation Officials (AASHTO).

THIRD — Standards published by the American Society for Testing and Materials (ASTM).

Section 1001

Hydraulic Cement

1001.01 DESCRIPTION. This section specifies the requirements for hydraulic cement in general use by the Department.

1001.02 PORTLAND CEMENT. Portland cement shall be from a source approved by the Department and shall conform to AASHTO Designation: M 85 with the following exceptions:

(a) All sampling shall be in accordance with the Department's Materials Sampling Manual.

(b) Testing frequency for air content will be based on randomly selected samples rather than testing every individual sample for specification requirements.

(c) The requirements for Type I portland cement are revised to require a coarser grind cement conforming to the following requirements when Type I(B) cement is used.

Turbidimeter Test	**Fineness**
Average value, max.	2000
Max. value, any one sample	2100
Air Permeability Test	**Fineness**
Average value, max.	3600
Max. value, any one sample	3800

(d) The alkalies calculated as sodium oxide and potassium oxide shall not exceed 0.85 percent for all types of cement.

1001.03 PORTLAND-POZZOLAN CEMENT. Portland-pozzolan cement shall be from a source approved by the Department and shall conform to ASTM Designation: C 595, Type IP, and shall contain 20 $\pm$ 5 percent fly ash or bottom ash provided the bottom ash is interground with the cement clinker. The fly ash or bottom ash shall conform to ASTM Designation: C 618, Class F, except that the loss on ignition shall not exceed 6 percent.

1001.04 MASONRY CEMENT. Masonry cement shall conform to AASHTO Designation: M 150.

Section 1002

Asphaltic Materials

1002.01 GENERAL. The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character, free from water, and shall not foam when heated to 350°F.

All storage tanks, piping, retorts, booster tanks, distributors and other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition at all times and shall be operated in such manner as to avoid contamination of the contents with foreign materials.

All final test results for the asphaltic materials will be applied to the proper schedule for conformance to the specifications. Any deviation from the specifications will result in an adjustment in unit price as specified.

The schedules contained herein will be used for the purpose of adjusting the appropriate unit prices of asphaltic materials. The adjustment in pay for asphaltic materials shall be applied only to samples taken at the point of delivery. All samples taken at the refinery shall be in accordance with the specification requirements. Should the sample fail to meet these requirements, the material will be rejected.

When the asphaltic materials do not conform to the requirements for 100 percent pay, and in the opinion of the engineer have resulted in an inferior or unsatisfactory product, the materials shall be removed and replaced or otherwise corrected by and at the expense of the contractor.

The intent of adjustments in pay for point of delivery samples is to allow partial payment for asphaltic materials which, in the judgment of the engineer, are satisfactory for use in the work and will serve the purpose intended, but which do not conform to the specifications in every detail.

If the test results are such that a price adjustment would result from more than 1 of the test values, only the price adjustment for the greatest reduction shall apply.

1002.02 ASPHALT CEMENT. When samples of AC-20 and AC-40 taken at the point of delivery or from the hot mix plant storage tanks do not meet the specification requirements as shown in Schedule No. 1, an adjustment in unit price will be made according to Schedule No. 1 provided the material is performing satisfactorily.

When samples of AC-5 or AC-10 taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 2, an adjustment in unit price will be made according to Schedule No. 2 provided the material is performing satisfactorily. All testing of asphalt cement, unless otherwise directed, shall be in accordance with the test methods given in Schedule Nos. 1 and 2.

1002.03 EMULSIFIED ASPHALT. The emulsified asphalt shall be homogeneous. When samples of SS-1 and SS-1h anionic emulsified asphalts taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 3, an adjustment in unit price will be made according to Schedule No. 3 provided the material is performing satisfactorily.

When samples of cationic emulsified asphalt CRS-2, CMS-2, and CSS-1h taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 4, an adjustment in unit price will be made according to Schedule No. 4 provided the material is performing satisfactorily.

When samples of cationic emulsified asphalt CQS-1h taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 5, an adjustment in unit price will be made according to Schedule No. 5 provided the material is performing satisfactorily.

All testing of emulsified asphalts, unless otherwise specified, shall be in accordance with the test methods given in Schedule Nos. 3, 4 and 5.

1002.04 CUTBACK ASPHALT. Cutback asphalts shall consist of liquid petroleum products produced by fluxing an asphaltic base with suitable petroleum distillates. The cutback asphalt shall show no separation or curdling prior to use and shall not foam when heated to the application temperature. When samples of cutback asphalt taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 6 for medium curing or Schedule No. 7 for rapid curing, an adjustment in unit price will be made according to Schedule Nos. 6 and 7 provided the material is performing satisfactorily.

All testing of cutback asphalts, unless otherwise specified, shall be in accordance with the test methods given in Schedule Nos. 6 and 7.

1002.05 UNDERSEALING ASPHALT. Whenever samples of the undersealing asphalt taken at the point of delivery do not meet the specification requirements as shown in Schedule No. 8 an adjustment in unit price will be made according to Schedule No. 8 provided the material is performing satisfactorily.

All testing of undersealing asphalt shall be in accordance with the test methods given in Schedule No. 8.

Schedule No. 1

ADJUSTMENT IN UNIT PRICE OF ASPHALT CEMENT, MODIFIED AASHTO GRADES AC-20 AND AC-40

Applicable to Asphaltic Concrete Mixtures		AC-20(*1) Percent of Contract Unit Price Per Unit of Measurement of Asphaltic Concrete Mix			AC-40(*1)		
		Specifications	Deviations		Specifications	Deviations	
		100%	99%	Remove or 90% Pay (*2)	100%	99%	Remove or 90% Pay (*2)
Applicable to Asphalt Cement As a Separate Item	**Test Method**	**Percent of Contract Unit Price Per Unit of Measurement of Asphalt Cement per Shipment**					
		Specifications	Deviations		Specifications	Deviations	
		100%	80%	Remove or 50% Pay (*5)	100%	80%	Remove or 50% Pay (*5)
Penetration, 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	65+ (*4)		59−	45+ (*3)		39−
Viscosity, 135°C (275°F), SSF (*6)	ASTM E 102	150+			200+		
Viscosity, 135°C (275°F), Cs	AASHTO T 201	300+	250-299	249− 1599−	400+	350-399	349− 3199−
Viscosity, 60°C (140°F), poises	AASHTO T 202	2000±400		2401+	4000±800		4801+
Solubility in Trichloroethylene, %	AASHTO T 44	99.0+			99.0+		
Flash Point, COC, °C (°F)	AASHTO T 48	232 (450)+		231(449)−	232 (450)+		231(449)−
Tests on Residue from Thin Film Oven Test:							
Viscosity, 60°C (140°F), poises	AASHTO T 202	8000−			16000−		
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	100+			100+		
Spot Test (Standard Naptha Solvent)	AASHTO T 102	Neg.			Neg.		

(*1) All values are inclusive.

(*2) If the material does not result in an inferior or unsatisfactory product, it may remain at 90% pay.

(*3) For samples obtained at point of delivery, the penetration requirement shall be 40+.

(*4) For samples obtained at point of delivery, the penetration requirement shall be 60+.

(*5) If the material does not cause unsatisfactory results, it may remain in place at 50 percent pay.

(*6) For samples obtained at point of delivery, the viscosity @ 275°F may be determined using ASTM E 102.

Schedule No. 2

ADJUSTMENT IN UNIT PRICE OF SURFACE TREATMENT ASPHALT CEMENT, MODIFIED AASHTO GRADES AC-5 AND AC-10

		Percent of Contract Unit Price Per Gallon of Asphalt Per Shipment					
		AC-5(*1)			AC-10(*1)		
		Specifications		Deviations	Specifications		Deviations
	Test Method	100%	80%	50% Pay or Remove (*2)	100%	80%	50% Pay or Remove (*2)
Penetration, 25°C (77°F), 100g, 5 sec.	AASHTO T 49	140+ (*3)		129−	85+ (*5)		79−
Viscosity, 135°C) (275°F), SSF (*4)	ASTM E 102	88+			125+		
Viscosity, 135°C (275°F), Cs	AASHTO T 201	175+	125-174	124−	250+	200-249	199−
				399−			799−
Viscosity, 60°C (140°F), poises	AASHTO T 202	500±100		601+	1000±200		1201+
Solubility in Trichloroethylene, %	AASHTO T 44	99.0+			99.0+		
Flash Point, COC, °C (°F)	AASHTO T 48	177(350)+		176(349)−	218 (425)+		217(424)−
Tests on Residue from Thin Film Oven Test:							
Viscosity, 60°C (140°F), poises	AASHTO T 202	2000−			4000−		
Ductility, 25°C (77°F), 5 cm/min.	AASHTO T 51	100+			100+		
Spot Test (Standard Naptha Solvent)	AASHTO T 102	Neg.			Neg.		

(*1) All values inclusive.

(*2) If the material does not cause unsatisfactory results, it may remain in place at 50% pay.

(*3) For samples obtained at the point of delivery, the penetration requirements shall be 130+.

(*4) For samples obtained at point of delivery, the viscosity at 275°F may be determined using ASTM E 102.

(*5) For samples obtained at the point of delivery, the penetration requirement shall be 80+.

Schedule No. 3

ADJUSTMENT IN UNIT PRICE OF ANIONIC EMULSIFIED ASPHALT

		Percent of Contract Unit Price Per Gallon of Asphalt per Shipment					
		SS-1			SS-lh		
		Specifications	Deviations		Specifications	Deviations	
	Test Method	100%	80%	Remove or 50% Pay *	100%	80%	Remove or 50 % Pay *
Viscosity, 25°C (77°F), SSF	AASHTO T 59	20-100	(10-19) (101-150)	(9−) (151+)	20-100	(10-19) (101-150)	(9−) (151+)
Residue by Distillation, % by wt.	AASHTO T 59	57 Min.	(52-56)	(51−)	57 Min.	(52-56)	(51−)
Sieve Test (Retained on No. 20)	AASHTO T 59	0.1 Max.	No Penalty		0.1 Max.	No Penalty	
Cement Mixing	AASHTO T 59	2.0 Max.	No Penalty		2.0 Max.	No Penalty	
Settlement, 5 days, %	AASHTO T 59	5 Max.	No Penalty		5 Max.	No Penalty	
Tests on Residue Penetration, 25°C (77°F), 100g, 5 sec.	AASHTO T 49	100-200	(88-90) (201-212)	(87−) (213+)	40-90	(30-39) (91-100)	(29−) (101+)
Solubility in Trichloroethylene, %	AASHTO T 44	97.5 Min.	No Penalty		97.5 Min.	No Penalty	
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	40 Min.	(26-39)	(25−)	40 Min.	(26-39)	(25−)

* If the material does not cause unsatisfactory results it may remain in place at 50% pay.

Schedule No. 4

ADJUSTMENT IN UNIT PRICE OF CATIONIC EMULSIFIED ASPHALT

		Percent of Contract Unit Price Per Gallon Per Shipment*								
		CRS-2			CMS-2			CSS-lh		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	100%	80%	Remove or 50% Pay	100%	80%	Remove or 50% Pay	100%	80%	Remove or 50% Pay
Viscosity, 50°C (122°F), SSF	AASHTO T 59	100-400	(56-99) (401-444)	(55−) (445+)	50-450	(26-49) (451-499)	(25−) (500+)			
Viscosity, 25°C (77°F), SSF	AASHTO T 59							(20-100)	(10-19) (101-150)	(9−) (151+)
Residue by Distillation, % by wt.	AASHTO T 59	65 Min.	(61-64)	(60−)	65 Min.	(61-64)	(60−)	57 Min.	(52-56)	(51−)
Oil Distillate by Volume, %	AASHTO T 59	3 Max.	No Penalty		12 Max.	No Penalty				
Particle Charge	DOTD TR 311	Pos.		Neg.	Pos.		Neg.	Pos.		Neg.
Sieve Test (Retained on No. 20)	AASHTO T 59	0.1 Max.	No Penalty		0.1 Max.	No Penalty		0.1 Max.	No Penalty	
Settlement, 5 Days, %	AASHTO T 59	5 Max.	No Penalty		5 Max.	No Penalty		5 Max.	No Penalty	
Tests on Residue										
Penetration, 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	100-250	(84-99) (251-266)	(83−) (267+)	100-250	(84-99) (251-266)	(83−) (267+)	(40-90)	(30-39) (91-100)	(29−) (101+)
Solubility in Trichloroethylene, %	AASHTO T 44	97.5	No Penalty		97.5	No Penalty		97.5	No Penalty	
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	80 Min.	(66-79)	(65−)	40 Min.	(26-39)	(25−)	40 Min.	(26-39)	(25−)
Viscosity, 135°C (275°F), cSt	AASHTO T 201	175 Min.	(125-174)	(124−)						

* If the unit of pay is not based on the gallon, the deduction shall be converted to an equivalent deduction in terms of unit of pay.

Schedule No. 5

ADJUSTMENT IN UNIT PRICE OF CATIONIC EMULSIFIED ASPHALT (CQS-1h)

		Percent of Contract Unit Price Per Gallon Per Shipment*		
		Specifications	Deviations	
	Test Method	100%	80%	Remove or 50% Pay
Viscosity, 25°C (77°F), SSF	AASHTO T 59	20-100	(10-19) (101-150)	(9−) (151+)
Residue by Distillation, % by wt.	AASHTO T 59	57 Min.	(52-56)	(51−)
Particle Charge	DOTD TR 311	Pos.		Neg.
Sieve Test (Retained on No. 20)	AASHTO T 59	0.1 Max.	No Penalty	
Settlement, 5 days, %	AASHTO T 59	5 Max.	No Penalty	
Mixing and Setting Properties	DOTD TR 315			
Mixing Test		Pass	No Penalty	
Setting Test		Pass	No Penalty	
Tests on Residue				
Penetration, 25°C (77°F) 100g, 5 Sec.	AASHTO T 49	40-90	(30-39) (91-100)	(29−) (101+)
Solubility in Trichloroethylene, %	AASHTO T 44	97.5	No Penalty	
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	40 Min.	(26-39)	(25−)

* If payment is not based on the gallon, the deduction shown will be converted to the equivalent deduction in terms of the unit of pay.

Schedule No. 6
ADJUSTMENT IN UNIT PRICE OF MC CUTBACK ASPHALT

		Deduction in Contract Unit Price/Square Yard of Base Course Represented(*)								
		MC-30			MC-70			MC-250		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	No Deduction	$0.03	$0.09	No Deduction	$0.03	$0.09	No Deduction	$0.03	$0.09
Flash Point, Open Tag, °C (°F)	AASHTO T 79	38 (100) Min.	No Penalty		38 (100) Min.	No Penalty		66 (150) Min.	No Penalty	
Viscosity, SSF	AASHTO T 72									
25°C (77°F)		75-150	(58-74) (151-167)	(57−) (168+)						
60°C (140°F)					35-70	(24-34) (71-81)	(23−) (82+)	125-250	(100-124) (251-275)	(99−) (276+)
Distillation Test, Distillate Percentage by Volume of Total										
Distillate to 360°C (680°F)	AASHTO T 78		No Penalty			No Penalty			No Penalty	
to 225°C (437°F)		0-25			0-20			0-10		
to 260°C (500°F)		40-70			20-60			15-55		
to 316°C (600°F)		75-93			65-90			60-87		
Residue from Distillation to 360°C (680°F), Percentage Volume by Difference		50 Min.	46-49	45—	55 Min.	51-54	50−	67 Min.	63-66	62−
Tests on Residue										
Penetration 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	120-250	(102-119) (251-268)	(101−) (269+)	120-250	(102-119) (251-268)	(101−) (269+)	120-250	(102-119) (251-268)	(101−) (269+)
Solubility in Trichloroethylene, %	AASHTO T 44	99.0	98.6-98.9	98.5−	99.0	98.6-98.9	98.5−	99.0	98.6-98.9	98.5−
Ductility, 25°C (77°F) for Residues to 200 Penetration, 5cm/min.	AASHTO T 51	100 Min.	76-99	75−	100 Min.	76-99	75−	100 Min.	76-99	75−
Ductility, 15.5°C (60°F) for Residues of 200-300 Penetration, 5cm/min.	AASHTO T 51	100 Min.	76-99	75−	100 Min.	76-99	75−	100 Min.	76-99	75−

* If the unit of pay is not based on the square yard, the deduction shall be converted to an equivalent deduction in terms of the unit of pay.

Schedule No. 7

ADJUSTMENT IN UNIT PRICE OF RC CUTBACK ASPHALT

		Percent of Contract Unit Price/Gallon Per Shipment								
		RC-70			RC-250			RC-800		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	100%	80%	50%	100%	80%	50%	100%	80%	50%
Flash Point, Open Tag, °C (°F)	AASHTO T 79				27 (80) Min.	No Penalty		27 (80) Min.	No Penalty	
Viscosity, SSF 60°C (140°F)	AASHTO T 72	35-70	(24-34)	(23−)	125-250	(100-124)	(99−)	400-800	No Penalty	
			(71-81)	(82+)		(251-275)	(276+)			
Distillation Test, Distillate Percentage by Volume of Total Distillate	AASHTO T 78		No Penalty			No Penalty			No Penalty	
to 360°C (680°F)		10 Min.								
to 190°C (374°F)		50 Min.			35 Min.			15 Min.		
to 225°C (437°F)		70 Min.			60 Min.			45 Min.		
to 260°C (500°F)		85 Min.			80 Min.			75 Min.		
to 316°C (600°F)										
Residue from Distillation to 360°C (680°F); Percentage Volume by Difference		55 Min.	51-54	(50−)	65 Min.	61-64	60−	75 Min.	71-74	70−
Tests on Residue										
Penetration 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	80-120	(66-79)	(65−)	80-120	(66-79)	(65−)	80-120	(66-79)	(65−)
			(121-134)	(135+)		(121-134)	(135+)		(121-134)	(135+)
Solubility in Trichloroethylene, %	AASHTO T 44	99.0	98.6-98.9	98.5−	99.0	98.6-98.9	98.5−	99.0	98.6-98.9	98.5−
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	100 Min.	76-99	75−	100 Min.	76-99	75−	100 Min.	76-99	75−

Schedule No. 8
UNDERSEALING ASPHALT

	Test Method	Percent of Contract Unit Price/Gallon of Asphalt		
		Specifications	Deviations	
		100%	80%	Remove or 50% Pay
Softening Point (Ring & Ball), °C (°F)	AASHTO T 53	82-93 (180-200)	77-81 (170-179) 94-99 (201-210)	76(169)− 100(211)+
Penetration of Original Sample:				
0°C (32°F) 200g, 60 Sec.	AASHTO T 49	5+		
25°C (77°F) 100g, 5 Sec.	AASHTO T 49	15-30	(10-14) (31-35)	(9−) (36+)
46°C (115°F) 50g, 5 Sec.	AASHTO T 49	60−	61-65	66+
Ductility, 25°C (77°F), 5cm/min.	AASHTO T 51	2+		Less Than 2
Flash Point (Cleveland Open Cup), °C (°F)	AASHTO T 48	218(425)+		No Penalty
Solubility in Trichloroethylene, %	AASHTO T 44	99.0+		No Penalty
Loss, 163°C (325°F) 5 hrs., %	AASHTO T 47	0.5−	0.5-1.0	1.0+
Penetration of Residue, % of Original	AASHTO T 49	70+	65-69	64−

Section 1003

Aggregates

1003.01 GENERAL. This section covers the specifications for aggregates in general use by the Department.

In order to determine the acceptability of these materials, it will be necessary to perform all of the applicable tests on each sample submitted as specified, with the following modifications:

(a) Los Angeles abrasion test and soundness test where specified shall be run on each new source. Periodic tests shall be run thereafter except that when the material is questionable, tests shall be run.

The abrasion and soundness tests shall be in accordance with AASHTO Designations: T 96 and T 104 except that for light weight aggregate, the abrasion test shall be performed in accordance with DOTD Designation: TR 111.

A permanent record of these test results on each source shall be maintained at the Department's Materials Laboratory.

When submitting samples of aggregates for testing, the supplier and geographical source of the material shall be given.

(b) Tests for deleterious substances shall be run only when it is evident by observation that the sample is contaminated except that it is required to run the colorimetric test on each sand sample submitted for approval.

(c) Coarse and fine aggregates for use in concrete that will be subject to wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any materials that are deleteriously reactive with the alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts, the aggregate may be used with a cement containing less than 0.6 percent alkalies calculated as sodium oxide and potassium oxide.

The alkali reactivity of the aggregate shall be determined in accordance with the procedures described in Appendix XI of ASTM Designation: C 33.

1003.02 FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE AND MORTAR. Sand shall be from a source approved by the

Department and shall consist of clean, hard, durable, siliceous grains substantially free from lumps of clay and all vegetable or other deleterious substances. The maximum percentages of deleterious substances shall not exceed the following values:

	Test Method	Percent (By Weight)
Material Passing No. 200 Sieve	DOTD TR 112	3.0
Coal or Lignite	AASHTO T 113	0.25
Clay Lumps	AASHTO T 112	0.5

The test for material passing No. 200 sieve, DOTD Designation: TR 112 shall be made prior to and on the same sample as is used for sieve analysis.

Fine aggregate subjected to the colorimetric test, AASHTO Designation: T 21, for organic impurities which produces a color darker than the Reference Standard Color Solution shall be subjected to the mortar strength test, AASHTO Designation: T 71, before acceptance. The fine aggregate, when subjected to the mortar strength test, shall show a minimum strength of 95 percent of the reference mortar.

Fine aggregate for concrete and mortar shall conform to the following gradation as determined by DOTD Designation: TR 113:

Concrete Sand

Sieve Size	Percent Passing (By Weight)
3/8″	100
No. 4	95 to 100
No. 16	45 to 90
No. 50	7 to 30
No. 100	0 to 7

Mortar Sand

No. 4	100
No. 8	95 to 100
No. 100	0 to 25
No. 200	0 to 10

1003.03 COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE. Coarse aggregate shall be from a source approved by the Department and shall be clean, hard, durable and reasonably free from dust, vegetable or other deleterious matter. Coarse aggregate shall show an abrasion loss of not more than 40 percent, and the maximum amounts of deleterious substances shall be as follows:

	Test Method	Percent (By Weight)
Material Passing the No. 200 Sieve	DOTD TR 112	1.0 *
Clay Lumps	AASHTO T 112	0.25
Soft Fragments	AASHTO T 189	5.0
Iron Ore (Included in Soft Fragments)		
Max. Retained 3/4''		1.5
Max. Passing 3/4''		0.5
Coal and Lignite	AASHTO T 113	1.0**
Sticks (Wet)		0.25
Totals: Clay Lumps, Soft Fragments, Coal and Lignite, and Sticks		5.0

* In crushed aggregates, if material finer than the No. 200 sieve consists of the dust of fracture essentially free of clay or shale, the percentage may be increased to 1.5.

**Aggregate used in railings shall be free from lignites.

All coarse aggregate shall be graded from coarse to fine, and when tested in accordance with DOTD Designation: TR 113, shall, except for lightweight, meet the following gradation requirements.

	Percent Passing (By Weight)			
U.S. Sieve	**Grade A**	**Grade B**	**Grade D**	**Grade E**
2-1/2''	----	----	100	*
2''	----	100	90-100	
1-1/2''	100	85-100	----	
1''	95-100	----	40-80	
3/4''	----	40-88	----	
1/2''	25-60	----	----	
No. 4	0-10	0-6	0-6	
No. 8	0-5	----	----	

* Gradation for Grade E aggregate is given below.

For Grade E the smaller size or larger size coarse aggregate may consist of either gravel or crushed stone conforming to the quality requirements of these specifications.

The individual grading of the 2 sizes of coarse aggregate shall be combined to meet the following gradation requirements:

Grade E

U.S. Sieve	Percent (By Weight)
Passing 2-1/2''	100
Passing 2-1/2'' Retained on 1-1/2''	25 to 40
Passing 1-1/2'' Retained on 3/4''	20 to 45
Passing 3/4'' Retained on No. 4	20 to 35
Passing No. 4, Not More Than	5

Unless written permission is obtained from the engineer, the individual sizes of coarse aggregate will be restricted as follows: The smaller size coarse aggregates for Grade E shall not have more than 10 percent retained on the one inch sieve, not less than 5 percent retained on the ¾ inch and not more than 8 percent passing No. 4. The larger size coarse aggregate for Grade E shall have 45 to 60 percent retained on the 1½ inch sieve and shall not have more than 20 percent passing the one inch sieve.

(a) Gravel, crushed stone, crushed slag, or a combination of gravel and crushed stone:

(1) Gravel: This aggregate shall be reasonably free of clay coating of any character. Gravel which contains disintegrated or soft stone or shale, or excess of flat pieces, shall not be used.

When subjected to 5 cycles of the magnesium sulfate soundness test, the weighted loss shall not exceed 15 percent.

(2) Crushed Stone: When subjected to 5 cycles of the magnesium sulfate soundness test, the weighted loss of the crushed stone shall not exceed 15 percent.

(3) Crushed Slag: Crushed slag shall consist of angular fragments reasonably free from flat or elongated pieces.

The crushed slag shall have a minimum dry rodded weight of 70 pounds per cubic foot when tested in accordance with AASHTO Designation: T 19, and shall be properly cured and stored such that it results in a chemically inert and stable aggregate. Because of its high absorption property, slag in stockpiles shall be kept uniformly wet.

Crushed slag shall contain not more than 10 percent by weight of glassy particles, and show an abrasion loss of not more than 40 percent. Higher percentages may be allowed for slags having demonstrated a satisfactory service record, at the discretion of the Department.

(b) Lightweight Coarse Aggregate: The 2 general types of lightweight coarse aggregate are aggregate prepared by expanding clay or shale by the rotary kiln process and aggregate prepared by crushing, screening and cleaning natural lightweight materials such as pumice, scoria or tuff.

In order for a source of lightweight aggregate to be approved, preliminary samples shall be submitted for testing at least 110 days prior to anticipated

use. All tests described herein shall be performed on the preliminary sample. Thereafter, only the tests for gradation, unit weight and fineness modulus will be performed for job control. However, a routine production sample will be taken each month as long as material is being supplied to jobs being constructed for or by the Department, and all tests described herein will be performed. These samples will be taken from a stockpile or from a day's run. However, if samples are taken from a day's run, the responsibility of shipping material which may fail the long range tests will be upon the supplier. All testing shall be in accordance with DOTD Designation: TR 107.

(1) Grading:

a. Lightweight aggregate shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight) Grade Y
3/4''	100
1/2''	90-100
3/8''	40-70
No. 4	0-15
No. 8	0-5

b. Uniformity of Grading: Samples of coarse aggregate representing the normal product of the plant shall be furnished for acceptance tests. Other samples shall be taken from shipments at intervals stipulated by the engineer. If the fineness modulus of the aggregate in any shipment differs by more than 7 percent from that of the sample submitted for acceptance tests, the aggregate in the shipment may be rejected.

(2) Unit Weight:

a. The unit weight of lightweight coarse aggregate shall not exceed 55 pounds per cubic foot, dry loose measurement.

b. Uniformity of Weight: If the unit weight of any shipment of lightweight coarse aggregate differs by more than 10 percent from that of the sample submitted for acceptance tests, the aggregate in the shipment may be rejected.

(3) Durability: The loss of lightweight coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 10 percent when magnesium sulfate is used. In lieu of this sulfate soundness test, a freezing and thawing test may be made on concrete prepared with the aggregate. Concrete having a cement factor of 6.0, 7.0 or 8.0 bags per cubic yard shall after 300 cycles of freezing and thawing have a durability factor of at least 75, 80 or 85 respectively. Intermediate values may be obtained by interpolation.

(4) Abrasion Resistance: Lightweight coarse aggregate shall show an abrasion loss of not more than 45 percent.

(5) Concrete Making Properties: Concrete specimens prepared with lightweight coarse aggregate and concrete sand shall have the following properties or meet the following requirements.

a. Compressive Strength and Unit Weight: Concrete cylinders, 6 inches in diameter by 12 inches high, prepared with plastic concrete having unit weights not exceeding those given in the following table shall at an age of 28 days have at least the minimum compressive strength and not more than the maximum dry unit weight shown. Intermediate values for unit weight and corresponding values for strength may be obtained by interpolation.

Compressive Strength and Unit Weight of Concrete

Plastic, Max. Lbs. per Cu. Ft.	Dry, Max. Lbs. per Cu. Ft.	Compressive Strength 28 days, Min., psi
120	115	4000
115	110	3000

b. Drying Shrinkage: The drying shrinkage of concrete specimens prepared and tested in accordance with Paragraph 2(i)(1) of DOTD Designation: TR 107 shall not exceed 0.10 percent or as tested in accordance with Paragraph 2(i) (2) of DOTD Designation: TR 107 shall not exceed 0.07 percent.

1003.04 BASE COURSE AGGREGATES.

(a) Sand Clay Gravel: Sand clay gravel shall be composed of a mixture of sand, clay and gravel or stone; an artificial mixture prepared by either the mixing of gravel or crushed stone, sand or binder; or by the addition of gravel or crushed stone and/or binder to natural sand clay gravel.

The mixture as determined by visual inspection shall be reasonably free from vegetable or other injurious matter.

When tested in accordance with DOTD Designations: TR 112 and TR 113 materials shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight)
1-1/2''	95 to 100
No. 4	40 to 75
No. 40	20 to 50
No. 200	12 to 25

The material passing the No. 40 sieve, when tested in accordance with

DOTD Designation: TR 428, shall show the following physical characteristics:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	6

If sand clay gravel is to be used for cement treatment, the maximum allowable liquid limit will be 35 and the maximum allowable plasticity index will be 12.

If sand clay gravel is to be lime treated, the maximum allowable liquid limit is waived. The plasticity index shall be within a range of 6-20.

As a matter of information but not limitation, the contractor is advised that the several materials may be combined in approximately the following proportions:

Gravel or Crushed Stone, percent	35
Sand, percent	47½
Binder, percent	17½

Gravel used in preparing an artificial mixture shall conform to Subsection 1003.05(a).

The binder material used either for preparation of an artificial mix or as an additive to sand clay gravel shall not have a plasticity index in excess of the plasticity index indicated above for the final product.

Crushed stone used in preparing an artificial mixture shall conform to Subsection 1003.05(b).

(b) Shell or Sand-Shell: Unless otherwise approved in writing by the engineer, the same base course mixture shall be used throughout the project.

(1) Shell Base Course: When shell base course is specified, the contractor has the option of furnishing shell with or without binder.

When shell without binder is used, the base course shall not be composed totally of clam shell but shall have a minimum of 30 percent by weight of reef shell as determined from samples taken prior to compaction. The percentage of clam shell will be determined in accordance with DOTD Designation: TR 110.

When shell with binder is used, the base course shall not contain more than 35 percent binder by volume, as verified by invoices for material placed in the base course.

(2) Sand-Shell Base Course: When sand-shell or cement treated sand-shell base course is specified, the binder content of the base course shall be a minimum of 20 percent and a maximum of 35 percent by volume, as verified by invoices for materials placed in the base course.

(3) Shell Materials: The shell may be whole or crushed or a combi-

nation thereof and shall consist of dead shell. Excessive amounts of degraded (fragmented) reef will not be permitted. The foreign matter content of the shell shall not exceed 5 percent of the dry weight of the sample when tested in accordance with DOTD Designation: TR 109.

(4) Binder Materials: The binder shall be siliceous material conforming to the following gradation requirements when tested in accordance with DOTD Designations: TR 112 and TR 113.

U.S. Sieve	Percent Passing (By Weight)
No. 4	85 to 100
No. 40	65 to 100
No. 200	0 to 60

The binder shall not contain more than a total of 4 percent by weight of foreign matter as determined by DOTD Designation: TR 413. When tested by DOTD Designation: TR 428, the binder shall meet the following physical characteristics:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	6

1003.05 SURFACE COURSE AGGREGATES.

(a) Gravel: Gravel shall consist of hard, durable, siliceous particles reasonably free of sticks and other deleterious matter, and when tested in accordance with DOTD Designation: TR 113 shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight)
1-1/2″	95 to 100
No. 4	0 to 15
Clay & Silt (DOTD TR 112)	2 percent max.

Gravel shall show an abrasion loss of not more than 45 percent.

(b) Crushed Stone: Crushed stone shall consist of fragments of hard, durable particles of stone showing an abrasion loss of not more than 45 percent, containing not more than 5 percent soft, friable material, and shall be free from an excess of flat or elongated pieces. When tested by DOTD Designation: TR 113 the material shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight)
1-1/2″	95 to 100
3/4″	65 to 95
No. 4	0 to 15

(c) Binder: The binder shall be siliceous material conforming to the following gradation requirements when tested in accordance with DOTD Designations: TR 112 and TR 113.

U.S. Sieve	Percent Passing (By Weight)
No. 4	85 to 100
No. 40	65 to 100
No. 200	10 to 60

Binder shall not contain more than a total of 4 percent by weight of foreign matter as determined by DOTD Designation: TR 413. When tested by DOTD Designation: TR 428, it shall meet the following physical characteristics:

Liquid Limit (Max.)	35
Plasticity Index	4-12

(d) Sand Clay Gravel: Sand clay gravel shall be a mixture of sand, clay and gravel; a mixture prepared by either the mixing of gravel or crushed stone, sand and binder; or by the addition of gravel or crushed stone and/or binder to natural sand clay gravel.

The mixture as determined by visual inspection shall be reasonably free from deleterious materials.

When tested in accordance with DOTD Designations: TR 112 and TR 113 the combined materials shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight)
1-1/2''	95 to 100
No. 4	40 to 75
No. 40	20 to 50
No. 200	12 to 25

The fraction of sand clay gravel passing the No. 40 sieve, when tested in accordance with DOTD Designation: TR 428, shall show the following physical characteristics:

Liquid Limit (Max.)	35
Plasticity Index	0-12

The binder material used for preparation of an artificial mixture of sand clay gravel shall not have a plasticity index in excess of the plasticity index indicated above for the final product.

When tested by the Los Angeles abrasion test, the fraction of the sand clay gravel retained on the No. 4 sieve shall show an abrasion loss of not more than 45 percent.

(e) Shell: Unless otherwise specified, the contractor has the option of furnishing shell with or without binder; however, the same surface course mixture shall be used throughout the project, unless otherwise approved in writing by the engineer.

When shell without binder is used, the surface course shall not be composed totally of clam shell but shall have a minimum of 40 percent by

weight of reef shell as determined from samples taken prior to placement. The percentage of clam shell will be determined in accordance with DOTD Designation: TR 110.

When shell with binder is used, the surface course shall contain 30 ± 10 percent binder material by volume as verified by invoices of materials placed in the surface course.

(1) Shell Materials: Shell in the mixture may be either whole or crushed or a combination thereof and shall consist of dead shell. Excessive amounts of degraded (fragmented) reef will not be permitted. The foreign matter content of the shell shall not exceed 10 percent of the dry weight of the sample when tested in accordance with DOTD Designation: TR 109.

When shell without binder is used, the materials shall conform to the following gradation requirements when tested in accordance with DOTD Designation: TR 113.

U.S. Sieve	Percent Passing (By Weight)
2''	95 to 100
No. 4	10 to 50
No. 16	4 to 25

(2) Binder Materials: The binder shall be siliceous material conforming to the following gradation requirements when tested in accordance with DOTD Designations: TR 112 and TR 113.

U.S. Sieve	Percent Passing (By Weight)
No. 4	85 to 100
No. 40	65 to 100
No. 200	0 to 60

The binder shall not contain more than a total of 4 percent by weight of foreign matter as determined by DOTD Designation: TR 413. When tested by DOTD Designation: TR 428, the binder shall meet the following physical characteristics:

Liquid Limit (Max.)	35
Plasticity Index	0-10

1003.06 ASPHALTIC SURFACE TREATMENT AGGREGATES. Aggregates for asphaltic surface treatment shall be from a source approved by the Department and may be uncrushed gravel; crushed aggregate (gravel, stone or slag); a combination of crushed and uncrushed gravel; or expanded clay aggregate.

(a) Crushed Gravel: This aggregate shall consist of clean, tough, durable stone and shall be crushed and screened to conform to the gradation specified. A minimum of 80 percent of the crushed gravel retained on the No. 10 sieve shall have one or more fractured faces. Crushed gravel shall

not show an abrasion loss of more than 40 percent and shall show a soundness loss of not more than 15 percent by weight when subjected to 5 cycles of the magnesium sulfate soundness test.

(b) Crushed Stone: This aggregate shall consist of clean, tough, sound, durable particles of stone. The particles of stone shall be reasonably free from dust, vegetable or other deleterious matter and shall not show an abrasion loss of more than 40 percent. The stone shall be reasonably free from an excess of flat or elongated particles and shall show a soundness loss of not more than 15 percent by weight when subjected to 5 cycles of the magnesium sulfate soundness test.

(c) Crushed Slag: Crushed slag shall consist of angular fragments reasonably free from flat or elongated pieces, dirt or other objectionable matter.

The crushed slag shall have a minimum dry rodded weight of 70 pounds per cubic foot when tested in accordance with AASHTO Designation: T 19, and shall be properly cured and stored such that it results in a chemically inert and stable aggregate.

Crushed slag shall contain not more than 10 percent by weight of glassy particles, and show an abrasion loss of not more than 40 percent. Higher percentages may be allowed for slags having demonstrated a satisfactory service record, at the discretion of the Department.

(d) Uncrushed Gravel: This aggregate shall consist of clean, tough, durable stone reasonably free from sticks and clay coating. Gravel shall be reasonably free from an excess of flat or elongated particles of stone and shall show an abrasion loss of not more than 40 percent and shall show a soundness loss of not more than 15 percent when subjected to 5 cycles of magnesium sulfate soundness test.

(e) Expanded Clay Aggregate: This aggregate shall be manufactured by the rotary kiln process and shall consist of angular fragments reasonably uniform in density and reasonably free from flat or elongated particles or other deleterious substances. Expanded clay aggregate shall show an abrasion loss of not more than 40 percent. The soundness loss shall not exceed 10 percent by weight when subjected to 5 cycles of the magnesium sulfate soundness test using No. 4 to ⅜ inch and ⅜ inch to ¾ inch size aggregate.

(f) Gradation Requirements: All the above types, when tested shall conform to the gradation requirements specified in Table I.

1003.07 AGGREGATES FOR ASPHALTIC CONCRETE.

(a) Type 1 Mixture: The aggregate shall consist of crushed gravel, crushed slag, crushed stone or a combination of these materials, sand and mineral filler.

Crushed shell aggregate is allowed in binder course mixtures.

Table I

Percent Passing (By Weight)

	Size 1 (Coarse)		Size 2 (Fine)		Size 3 (Seal)
U.S. Sieve	Uncrushed Gravel or Crushed Aggregate	Expanded Clay Aggregate	Normal Gradation 3 Application Surface Treatment	*Gradation for 2 Application Surface Treatment (Shoulders only)	
1½''	100	100	—	—	
1''	85-100	95-100	—	—	
¾''	40-80	70-90	100	100	
⅝''	—	—	95-100	95-100	
½''	0-15	—	—	60-90	100
⅜''	—	—	—	—	90-100
No. 4	—	0-5	0-7	0-10	15-60
No. 10	—	—	—	—	0-15
No. 16	—	—	—	—	0-5

* Size 2 cover material for use with two application surface treatment for shoulders shall conform to the gradation requirements referenced to this note.

(1) Crushed Gravel: Crushed gravel shall be from a source approved by the Department and shall consist of clean, hard, tough, durable fragments, screened and crushed to meet the grading requirements. Gravel shall not show an abrasion loss of more than 40 percent. It shall show a soundness loss of not more than 15 percent by weight when subjected to 5 cycles of the magnesium sulfate soundness test.

(2) Crushed Stone: This aggregate shall be from a source approved by the Department and shall consist of clean, hard, durable fragments reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter. Crushed stone shall not show an abrasion loss of more than 40 percent.

When subjected to 5 cycles of the magnesium sulfate soundness test, the weighted loss shall not exceed 15 percent. Higher percentages may be allowed for stone having a satisfactory service record, at the discretion of the Department.

(3) Crushed Slag: This aggregate shall be from a source approved by the Department and shall consist of angular fragments, reasonably free from flat or elongated pieces.

The crushed slag shall have a minimum dry rodded weight of 70 pounds per cubic foot when tested in accordance with AASHTO Designation: T 19, and shall be properly cured and stored such that it results in a chemically inert and stable aggregate.

Crushed slag shall contain not more than 10 percent by weight of glassy particles, and show an abrasion loss of not more than 40 percent. Higher percentages may be allowed for slags having demonstrated a satisfactory service record, at the discretion of the Department.

(4) Sand: Sand shall consist of clean, hard, durable, siliceous grains graded from coarse to fine and shall be reasonably free from vegetable matter or other deleterious substance. The fraction passing the No. 40 sieve shall be non-plastic.

The sand equivalent value of the fraction passing the No. 4 sieve shall not be less than 35 when tested in accordance with AASHTO Designation: T 176 (Alternate Method No. 1 — Air Dry). These tests shall be performed when deemed necessary by the engineer.

(b) Type 2 Mixture: The aggregate shall consist of crushed clam shell, crushed reef shell or a combination thereof; sand; and mineral filler, when needed. These materials shall meet the following requirements.

Shell shall consist of dead clam shell or dead reef shell, reasonably free from objectionable material such as sticks or coating of mud or other foreign matter. However, foreign matter such as sand, silt or clay will be permitted in an amount not exceeding 5 percent by weight when dry, as determined by DOTD Designation: TR 109, provided such material is dispersed throughout the mass.

Sand shall conform to the requirements specified under Heading (a) of this Subsection.

(c) Type 3 Mixture: The aggregate shall consist of the following:

(1) Wearing Course Mixture: Crushed gravel, crushed slag, crushed stone, combined with screenings of gravel, stone, slag or other approved materials; sand; and mineral filler.

(2) Binder Course: The aggregate shall be the same as Type 1 binder course, described under Heading (a) of this Subsection.

All materials for Type 3 mixes shall conform to the requirements under Heading (a) of this Subsection.

Screenings shall be made by crushing any of the approved aggregates which prior to crushing conformed to the requirements under Heading (a) of this Subsection.

The Type 3 wearing course mixtures shall contain a minimum of 15 percent screenings based on total aggregates as approved by the engineer; however, the amount of screenings required may exceed the minimum if deemed necessary to meet the optimum physical properties.

The screenings shall be a natural crusher run material meeting the following gradation. When gravel is used for screenings, it shall be washed gravel and shall not have more than 10 percent passing the No. 4 sieve

prior to crushing and shall meet the following gradation requirements after crushing when tested in accordance with DOTD Designation: TR 113.

U.S. Sieve	Percent Passing (By Weight)
3/8''	100
No. 4	90 to 100
No. 40	10 to 45

The screenings shall be stockpiled separately and fed into the plant through a separate cold feed. The percent of screenings used in the mix will be determined volumetrically at the cold feed.

This measurement will be made by the ratios of the gate openings at the cold feed for plants that have a constant feed for all the cold feed bins. For plants that have variable speed cold feed belts, the percent of screenings will be determined by measuring the percent of screenings by volume of the total volume of aggregate on a given section of belt.

The sand shall conform to the requirements under Heading (a) of this Subsection.

(d) Type 4 Mixture: The aggregate shall consist of expanded clay aggregate, sand and mineral filler. These materials shall meet the following requirements.

Expanded clay aggregate shall be manufactured by the rotary kiln process and consist of angular fragments reasonably uniform in density and reasonably free from flat or elongated pieces or other deleterious substances. Expanded clay aggregate shall not show an abrasion loss of more than 40 percent. The expanded clay aggregate shall have a dry rodded weight per cubic foot of not more than 50 pounds when tested in accordance with AASHTO Designation: T 19. The percent loss shall not exceed 10 percent after 5 cycles by the magnesium sulfate soundness test.

Sand shall conform to the requirements specified under Heading (a) of this Subsection.

(e) Type 5 Mixtures:

(1) Type 5A: The aggregate shall consist of gravel, slag, stone, reef shell, clam shell or expanded clay, sand and mineral filler when needed.

(2) Type 5B: The aggregate shall consist of gravel, slag, stone, reef shell, clam shell, expanded clay and sand; or sand clay gravel.

Pit run sand clay gravel may be used in Type 5B mixes provided the material is separated into two distinct sizes prior to final mixing. The separation shall be done by using a No. 4 screen or other approved sizes. For batch plants the screening process must be adequate to satisfy this requirement.

(f) Mineral Filler: Mineral filler shall consist of limestone dust, pulverized hydrated lime, silica dust, shell dust, portland cement, cement

stack dust or other approved material.

Blending of pulverized anhydrous calcium sulfate (anhydrite) with the mineral fillers will be permitted provided the anhydrite does not constitute more than 30 percent of any blend with one or more of the other approved fillers.

The quantity of anhydrite in a blended filler will be determined by DOTD Designation: TR 501.

The anhydrite shall not be contaminated with clay or other plastic mineral matter and shall conform to the requirements herein for mineral fillers.

The portion of pulverized anhydrite passing the No. 200 sieve shall not constitute more than 25 percent of the total material passing the No. 200 sieve, including natural fines, in any paving mixture.

Anhydrite shall not constitute more than 2 percent of the total aggregate, including all sizes, for any paving mixture.

The cement stack dust shall consist of material collected from waste rotary kiln gases discharged through a collector of a cement plant.

Limestone dust, silica dust, shell dust, cement stack dust, or a blend of one of these fillers with anhydrite dust, or a blend of anhydrite with hydrated lime or portland cement shall be obtained from sources approved by the Materials Section, and, when tested in accordance with DOTD Designation: TR 102, shall meet the following gradation requirements.

U.S. Sieve	Percent Passing (By Weight)
No. 30	100
No. 80	95 to 100
No. 200	70 to 100
No. 270	60 to 100

Mineral dust collected in bag houses of asphaltic concrete plants may be used as mineral filler in accordance with the following requirements. This type mineral filler that is produced by each plant must be approved by the Laboratory prior to use and the quantity required will be determined by the Materials Laboratory. Provisions must be made at the plant so the amount of mineral dust from the bag houses that is added to the mixture can be readily determined. When the quantity of mineral dust being produced is less than that required in the mixture design, this material can be supplemented by the addition of an approved commercial filler.

Whenever mineral fillers are to be approved for use in asphaltic mixtures, the Laboratory will prepare mixtures of aggregate, filler and asphalt in proportions to meet the requirements of mixes being utilized, and this mixture shall have an index of retained Marshall stability of at least 75 percent, and a maximum of 1.0 percent volumetric swell as determined in accordance with DOTD Designation: TR 313.

After approval of the source and preliminary samples of limestone, silica, shell dust, cement stack dust or other approved materials are furnished for mineral filler for the project, the Laboratory will approve individual shipments on sieve analysis only.

Whenever portland cement or hydrated lime is used, tests for gradation requirements will not be made.

1003.08 GRANULAR MATERIAL. Granular material shall be nonplastic, having clean, hard, durable, siliceous grains; and when tested in accordance with DOTD Designations: TR 112 and TR 113, shall meet the following gradation requirements:

U.S. Sieve	Percent Passing (By Weight)
1/2''	100
No. 10	75-100
No. 200	0-15

Section 1004

Masonry Units

1004.01 SEWER BRICK. Sewer brick may be made from clay, shale or concrete meeting the following requirements.

Brick made from clay or shale intended for use in inlets, pipe junctions, catch basins, arches, manholes and for backings shall conform to AASHTO Designation: M 91, Manhole Brick Grade MM.

Concrete brick shall meet the requirements of ASTM Designation: C 139, except that the minimum thickness of each unit shall not be less than 3⅝ inches.

1004.02 BUILDING BRICK.

(a) Building brick made from clay or shale for use in brick masonry shall conform to AASHTO Designation: M 114, Grade SW.

(b) Concrete building brick for use in masonry buildings shall conform to ASTM Designation: C 55, Grade N-II.

1004.03 CONCRETE BUILDING BLOCK. Concrete hollow load-bearing building block shall conform to ASTM Designation: C 90, Grade N-II.

1004.04 CELLULAR CONCRETE BLOCKS. Cellular concrete blocks shall be manufactured by machines employing high vibratory compaction. The blocks shall conform to ASTM Designation: C 145, Grade N-II, except the oven-dry weight of concrete shall be at least 130 pounds per cubic foot based on bulk specific gravity. Aggregate gradation and permissible block dimension variations shall be as directed.

Section 1005

Joint Materials for Pavements and Structures

1005.01 JOINT FILLERS. These preformed fillers shall be used in joints when specified in accordance with the plans and project specifications. Unless otherwise specified, the contractor may use any of these approved preformed fillers for its intended use. Other preformed fillers may be approved by the Department and specified in the plans or project specifications.

In the absence of detailed material specifications, the contractor shall furnish certificates of analysis of materials proposed for use together with their specification requirements and recommended uses.

(a) Preformed Expansion Joint Fillers for Concrete Paving and Structures:

(1) Nonextruding and Resilient Bituminous Types: Fillers shall consist of preformed strips which have been formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly saturated with a suitable bituminous binder, or strips which have been formed from clean granulated cork particles securely bound together by a suitable bituminous binder and encased between two layers of felt.

The type shall be as specified and shall conform to AASHTO Designation: M 213.

(2) Nonextruding and Resilient Nonbituminous Types: Fillers shall consist of preformed expansion joint fillers of the following types:

Type I	Sponge Rubber
Type II	Cork
Type III	Self-Expanding Cork

The type shall be as specified and shall conform to AASHTO Designation: M 153.

(3) Bituminous Type: Bituminous preformed expansion joint filler shall consist of bituminous (asphalt or tar) mastic composition, formed and encased between two layers of bituminous impregnated felt. The preformed filler shall conform to ASTM Designation: D 994.

(b) Wood Fillers: The boards shall be clear heart redwood, clear all heart western red cedar, Idaho white pine, western white spruce, northern white pine, sugar pine, western hemlock or white fir. All species other than redwood or cedar shall be treated with preservatives. Occasional medium surface checks will be permitted provided the board is free of any defects that will impair its usefulness for the purpose intended. No board of a length less than 6 feet may be used and the separate pieces shall be held securely to form a straight line.

The preservative treatment for wood other than redwood shall be ammoniacal copper arsenate or chromated copper arsenate conforming to AWPA P5 with a minimum retention of 0.4 lb./cu. ft.

The dimensions shall be as specified and a tolerance of +1/16 inch thickness, + ⅛ inch depth and ± ¼ inch length will be permitted.

The load required to compress the material in an oven-dry condition to 50 percent of its original thickness shall not exceed 1800 lbs. per square inch.

(c) Preformed Nonbituminous Cellular Filler (For Sawed Joints): This filler shall consist of preformed strips which have been formed from cane or other suitable fibers of a cellular nature, or laminated fiber boards built up to plan thickness. The material forming these strips shall be securely bound together with a suitable nonbituminous binder and formed to the plan dimensions.

The preformed strips shall meet the following:

(1) Water Absorption: When tested in accordance with AASHTO Designation: T 42, the sample shall not absorb more than 15 percent by volume in 4 hours.

(2) Permissible Variation in Dimensions: The preformed filler shall not vary from the thickness specified by more than ± 1/16 inch.

(d) Preformed Polyvinylchloride Joint Filler: This filler shall be an approved, extruded insert material (with or without removable cap as required) composed of polyvinylchloride of the required depth and thickness. It shall possess sufficient rigidity to enable it to form a straight joint.

(e) Preformed Closed Cell Polyethylene Joint Filler: This material is primarily used in pavements and structure joints whose slabs are tied together with steel thus exhibiting minimal thermal movement. It is also used in pressure relief joints for concrete pavement approaches and bridge approach slabs as shown on the plans. The dimensional requirements shall be as specified on the plans.

The joint filler shall be formed by the expansion of polyethylene base resin, extruded as a multicellular, closed cell, homogeneous section of foamed polyethylene. This material shall be used with an adhesive as recommended by the manufacturer. The Materials Section shall maintain a Qualified Products List of joint fillers and adhesives to be used with each.

The Department may require a filler to prove its performance through field installation and evaluation prior to placement upon the Qualified Products List. The joint filler shall meet the following requirements:

Property	Test Method	Limit
Density, pcf	ASTM D 1564	2.0-3.0
Water Absorption, % by volume, max.	ASTM C 272 (Note 1)	1.0
Compression, psi	ASTM D 1056	
@ 20% deflection, min.		3.0
@ 80% deflection, max.		125.0
Extrusion @ 80% deflection, inches per inch width, max.	ASTM D 545	0.03

Note 1: The requirement that materials which trap water in flutes be dipped in absolute alcohol shall be omitted. Instead, the joint filler shall be dried quickly by blotting with absorbent paper.

(f) Cellular Polystyrene Joint Filler: This material shall conform to ASTM Designation: D 2125-62T with the following specific requirements:

Density shall be 2 pounds per cubic foot ($\pm$ 0.2) and shall be an extruded type of homogeneous foam with a maximum of 30 psi compressive strength.

1005.02 POURED JOINT SEALERS. These joint sealers shall be used in sealing joints when specified in accordance with the plans and project specifications. If not specified, the contractor may use any of these approved sealants for its intended use. Other sealants may be approved by the Department and specified in the plans or project specifications.

(a) PVC Extended Coal Tar: This material shall be an approved single component polymer type elastomeric compound meeting the following physical requirements:

Property	Test Method	Requirements
Penetration	AASHTO T 187	130 max.
Flow	AASHTO T 187 (Note 1)	None
Bond	AASHTO T 187	1/4'' separation max.
Resilience, %	DOTD TR 623	60 min.
Ball Penetration		5-20
Artificial Weathering	DOTD TR 623	Pass

Note 1: The test for flow shall be conducted according to AASHTO T 187 with the following exception: The sample shall be placed in an oven maintained at 150° ± 2°F for 24 hours.

Back-up material and elastomeric polymers shall be approved products on the Qualified Products List. Once a product is approved for joint sealing, the requirements shall continue to be met for every lot produced.

(b) Polyurethane Polymers (Liquid Poured): This joint sealer shall be a one or two component, pourable or extrudable material. It shall set up as a solid rubber-like material able to withstand both tension and compression. This sealer shall not flow at temperatures below 160°F.

The joints shall be backed with joint fillers of a type specified by the manufacturer to obtain the correct depth of sealant. This backing material must not adhere to the sealant material.

The primer-adhesive shall be as recommended by the sealant manufacturer for the proper joint interface.

Primers, back-up materials and elastomeric polymers shall be approved products on the Qualified Products List. Once a product including corresponding primer and back-up material is approved for a joint sealer, these requirements shall continue to be met for every lot produced.

Each container of material shall be properly marked as to material, identity, batch number and manufacture date. Three copies of certificates of compliance and analysis shall be furnished for each project and batch.

Shelf life shall be specified by the manufacturer, and the expiration date shall be clearly shown on the container. All joint sealing compounds shall have passed all qualification tests which includes actual field installation and evaluation. All material furnished shall be equal in composition to the original sample which has been tested and approved as a qualified product. Any deviation in composition or performance of the product shall result in it being removed from the Qualified Products List.

In addition, for verification purposes the material shall meet the following requirements:

Property	Limits	Test Method
Tack-Free Time, hours	72 (Max.)	Fed. Spec. TT-S-00227E
Hardness, Shore A		Fed. Spec. TT-S-00227E
After Heat Aging	20-50	
Standard Condition	5-30	
Weatherometer, 600 hrs. (min.)	Pass	DOTD TR 611
Ozone	Pass	ASTM D 1149
Weight Loss, %	10 (Max.)	Fed. Spec. TT-S-00227E

Property	Limits	Test Method
Infrared Charts		DOTD TR 610
Activator	Pass	
Base Resin	Pass	

(c) Asphaltic Types:

(1) Asphalt with Mineral Filler: Asphalt mineral filler shall be homogeneous and shall be composed of asphalt and mineral filler. The asphalt shall be free from impurities. The asphalt mineral filler shall conform to the following requirements:

	AASHTO Test Method	Min.	Max.
Softening Pt., °F	T 53	125	145
Penetration at 32°F, 200g, 60 sec.	T 49	14	———
Penetration at 77°F, 100g, 5 sec.	T 49	50	70
Ductility at 77°F, cm	T 51	15	———
Asphalt Solubility, %	T 44	45	55
Mineral Filler, %	T 44	45	55
Water, %	T 55	———	2

(2) Hot Poured Elastic Type: Hot poured elastic type sealer is intended for sealing joints in concrete pavements, bridges and other structures and shall conform to AASHTO Designation: M 173, except the pour point test will be performed only as deemed necessary.

(3) Catalytically Blown Asphalt: Catalytically blown asphalt shall be uniformly blended with 10 percent diatomaceous earth filler which passes the No. 325 sieve. It shall form a suitable joint and crack sealer which may be melted to pouring consistency in a regular asphalt kettle at a temperature of 400 to 485°F. The material shall meet the following requirements:

Type-Grade	AASHTO Test Method	Min.	Max.
Penetration, 77°F, 100 g, 5 Sec.	T 49	68	88
Penetration, 32°F, 200g, 60 Sec.	T 49	38	———
Penetration, 115°F, 50g, 5 Sec.	T 49	———	160
Softening Point, R & B., °F	T 53	175	200

Type-Grade	AASHTO Test Method	Min.	Max.
Flash, C.O.C., °F	T 48	500	———
Specific Gravity 77/77°F	———	1.02	———
Ductility, 77°F, 5 cm/min, cms.	T 51	5	———
Flow, 140-F, cm	T 187	———	0.5
Ash Weight, %	T 111	8	20
Shock Test, 30°F	M 190-5(c)(1)	No cracking	

1005.03 PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL. The joint seal shall be an approved preformed elastomeric polychloroprene joint seal which shall be compatible with concrete and steel and shall be resistant to abrasion, oxidation, oils, gasoline, salt and other substances that may be spilled on or applied to the surface.

The Materials Section maintains a Qualified Products List of compression seals. The Department may require a seal to prove its performance through field installation and evaluation prior to placement upon the Qualified Products List. All material furnished shall be equal in composition, shape and physical characteristics to the original sample which has been tested and approved as a qualified product.

When the seal size is not stated on the plans, the size shall be selected as a seal with a nominal width that is double the joint's theoretical width at maximum closure.

Unless otherwise noted, the width of the joint seal to be used shall be determined on the basis of temperature range, between 20°F and 120°F for structural steel, and between 30°F and 100°F for structural concrete.

The uncompressed depth of the seal shall be approximately equal to or greater than the uncompressed width of the seal. The actual width of the seal shall not be less than the nominal width of the seal.

Each lot of joint sealer submitted for Department approval shall demonstrate that it possesses the inherent capabilities necessary for satisfactory field installation. This property shall be judged by actual installation, and the sealer shall not exhibit any twisting, rolling, misalignment of the opposite top edges, tendencies to trap incompressibles or any other qualities which shall be deemed detrimental to the sealer's proper installation and performance.

The seal will be tested for compression-deflection in accordance with DOTD Designation: TR 612.

(a) **Pavement Use:** The material shall conform to ASTM Designation: D 2628 with the following exceptions.

(1) The test for ozone resistance may, at the option of the Department, be determined by the bent loop test method.

(2) The seal shall exert a minimum pressure of 3.0 pounds per square

inch at 80% of nominal width and a maximum of 25.0 pounds per square inch at 50% of nominal width.

The lubricant-adhesive shall conform to ASTM Designation: D 2835.

(b) Bridge Use: The seal shall conform to 1005.03(a) with the following exceptions:

(1) The seal shall exert a minimum pressure of 4.0 pounds per square inch at 80 percent of nominal width.

(2) Lubricant Adhesive: The material shall be compatible with concrete, steel and polychloroprene and must be of a character that is recommended by the sealant manufacturer. The material shall not necessarily be from the same base polymer as the seal; however, each type of lubricant adhesive shall demonstrate by actual test installation that it posesses the inherent capabilities necessary for satisfactory performance. The lubricant-adhesive shall provide adequate lubrication for insertion of the seal into the joint, and shall bond the seal to the joint faces throughout repeated cycles of expansion and contraction, effectively sealing the joint against infiltration or moisture.

It shall exhibit a viscosity of 16,000 to 450,000 centipoises and a minimum shear ratio of 2.5. It shall have a minimum lubricating life of two hours at 100°F, and shall cure within 48 hours without sagging.

No material shall be used which has skinned over or which has settled in the container to the extent that it cannot be easily dispersed by hand stirring to form a smooth uniform product.

The material shall be uniform, homogeneous, contain no lumps or agglomerates, and there shall be no settlement in the container. The minimum percent solids is 65 percent and shall be determined by oven drying at 230° ± 5°F for 3 hours.

All material furnished shall be equal in composition to the original sample which has been tested and approved for the Qualified Products List. The manufacturer shall provide a certificate of compliance for each lot produced for each project.

The lubricant-adhesive shall be delivered in containers plainly marked with the manufacturer's name or trademark, lot number, date of manufacture and storage stability.

1005.04 STEEL REINFORCED ELASTOMERIC JOINT SEALS. This material shall consist of integrally molded units of elastomer and bonded metal components so arranged as to provide for the expansion and contraction joint movements. The metal components bridging the joint gap shall be of sufficient strength to carry wheel loads across the joint. The total system with components shall be as approved on the Qualified Products List.

The expansion joints shall seal the deck surface, gutters and curbs to pre-

vent moisture and other contaminants from descending onto the pier and abutment caps and shall have provision for adequate anchoring of the joint assembly to the bridge deck. The gutter and vertical curb face shall be one piece. There shall be no appreciable change in the deck surface with the bridge expansion and contraction movements. All the expansion and contraction movements of the bridge deck shall be taken entirely by deformation of the elastomer.

The elastomer portion of the elastomeric compound for expansion joints shall be 100 percent virgin chloroprene and shall have the following physical properties:

Property	ASTM Test Method	Requirement
Tensile Strength, min., psi	D 412	1800
Elongation at break, min., %	D 412	400
Hardness, Type A Duro., points	D 2240	45 ± 5
Compression Set, 22 hours at 158°F, max., percent	D 395	20
Low Temperature, Brittleness @ −40°F	D 746 Procedure B	No Failure
Ozone Resistance Exposure to 100pphm ozone for 70 hrs. @ 104°F, sample under 20% strain or bent loop	D 1149	No Cracks
Oil Deterioration ASTM Oil No. 3 for 70 hours @ 212°F, Vol. Change, max., %	D 471	120

The dimensions of the elastomeric portion of the joint shall be correct to − 0 inch + ¼ inch in width and length, and from − 0 inch + ⅛ inch in thickness of the exterior dimensions required on the plans, measured at 70°F.

The sealant for sealing joints between the expansion joint units, along the edge of the expansion joint, and the bolts and plugs shall be as listed on the Qualified Products List. It shall be capable of bonding to concrete, steel and

elastomer. When cured, the sealant shall possess excellent abrasion resistance and shall resist attack by salt, oil and road chemicals.

The internal steel plates shall conform to ASTM Designation: A 570, Grade D, or A 36. The plates will be bonded to the rubber during the vulcanization process. They shall not be exposed to the atmosphere.

The supplier shall furnish the Materials Section a certificate of compliance for the steel used, and a certificate of analysis for the elastomer used in this system.

1005.05 JOINT MATERIALS FOR APPROACH SLABS.

(a) Preformed Closed Cell Polyethylene Joint Filler: This material shall conform to Subsection 1005.01(e).

Lubricant-adhesive shall be used and applied according to the manufacturer's instructions.

(b) Preformed Urethane Foam Joint Filler: This material shall be made with a semi-open, flexible polyurethane foam which is molded to such cross-sectional shape that it can be easily installed in the pavement joint with parallel sides and which will be sufficiently self-locking to prevent the material from floating out of the joint. When the joint filler is used to form the joint, the self-locking feature will not be required and the joint filler will exent full depth.

The properties of the urethane foam when determined on skinfree specimens shall meet the following requirements:

Property	Requirements	Test Method
Density, pcf	7-11	ASTM D 1564
Compression, psi		ASTM D 1564
25% Deflection	3-7	
65% Deflection	8-16	
Recovery, % of original, min.	95	65% deflection, calculated after 1 minute of relaxation from deflection return.
Tensile Strength, psi, min.	25	ASTM D 1564
Water Absorption, % Vol, max. one inch thick specimen	30	AASHTO T 42
Chemical Resistance —	Immerse a specimen approximately 0.5 cubic inch in volume in a 50% by volume mixture of mineral spirits and linseed oil for 24 hours. Remove and visually examine the specimen for evidence of deterioration.	

A lubricant adhesive, recommended by the manufacturer for the intended use, shall be provided with the joint filler, and liberally used according to his instructions.

(c) **Preformed Elastomeric Compression Joint Seal:** This material shall conform to Subsection 1005.03(b).

1005.06 WATERSTOPS. Waterstops shall be of the type and dimension shown on the plans and conform to the following requirements:

(a) **Copper waterstops** shall conform to ASTM Designation: B 370, soft temper.

(b) **Polyvinylchloride waterstops** shall conform to Corps of Engineers Specification CRD-C 572.

(c) **Rubber waterstops** shall conform to Corps of Engineers Specification CRD-C 513.

Details of installation and splicing, when not shown on the plans, shall be submitted to the Materials Engineer for approval. Copper and rubber waterstops shall be sampled in accordance with the Department's Materials Sampling Manual. When polyvinylchloride waterstops are used, the contractor shall submit a certificate of analysis indicating conformance to all requirements of the specification.

Section 1006

Concrete, Clay, Asbestos-Cement, Bituminized Fiber and Plastic Pipe

1006.01 GENERAL. Portland-pozzolan cement conforming to Subsection 1001.03 may be used in the manufacture of all concrete pipe and arch.

1006.02 GASKET MATERIALS FOR PIPE.

(a) Rubber Gaskets: Rubber gaskets for pipe joints shall conform to AASHTO Designation: M 198, Type A.

Each pipe manufacturer or supplier shall furnish certificates of analysis covering each shipment of gaskets to the Department's Materials Section stating that the gaskets conform in all respects to the above specifications.

(b) Flexible Plastic Gasket: Flexible plastic gaskets for use in pipe joints shall conform to AASHTO Designation: M 198, Type B.

The Materials Section shall maintain a Qualified Products List of approved gaskets. All material furnished shall be equal in composition, shape and physical characteristics to the original sample which was tested and approved as a qualified product.

(c) Sealants: The Materials Section shall maintain a Qualified Products List of approved pipe joint sealants. All material furnished shall be equal in composition, shape and physical characteristcs to the original sample which was tested and approved as a qualified product.

1006.03 NONREINFORCED CONCRETE PIPE. Nonreinforced or plain concrete sewer pipe shall conform to ASTM Designation: C 14.

1006.04 REINFORCED CONCRETE PIPE. Reinforced concrete pipe shall conform to ASTM Designation: C 76, amended as follows.

(a) Unless otherwise specified, Class III Reinforced Concrete Pipe, Wall A, B or C (Table 3) shall be furnished.

(b) When extra strength pipe is required, Class IV Reinforced Concrete Pipe, Wall A, B or C (Table 4) shall be furnished.

(c) The pipe shall be tested for permeability as specified in ASTM Designation: C 14. Frequency of testing shall be a minimum of one pipe per lot of sizes up to and including 48 inches in diameter and not to exceed one

test per 1000 joints of pipe manufactured. The absorption test specified in ASTM Designation: C 76 will be conducted at the discretion of the engineer in cases where the pipe exhibits visual porosity.

(d) Pipe for Type 3 joints shall have joints conforming to AASHTO Designation: M 198 with the following modifications:

(1) General: No reinforced concrete pipe used shall have joints with a taper of more than 12° and the maximum allowable differential between the joint taper of the bell and the spigot, or tongue and groove, shall be 1° with the following exception. A maximum allowable differential between the tongue and groove may be 2° provided the taper is 6° or less and it will pass the 10 psi hydrostatic pressure test. When the depth of the groove (bell) and length of the tongue (spigot) is less than 2½ inches, the pipe will be required to pass the 10 psi hydrostatic pressure test. Except for pipe sizes 15 inches in diameter and under, this hydrostatic test will not be required provided the groove and tongue depth is at least 2 inches.

(2) Joints for use with gasket material conforming to Subsection 1006.02(a) which have a taper of less than 6° will not require the hydrostatic pressure test except as provided in paragraph (1). If the taper of the joint exceeds 6° and is not greater than 8°, its use will be permitted provided the joint will pass the 10 psi hydrostatic pressure test.

(3) Joints for use with gasket material conforming to Subsection 1006.02(b) which have a taper of 10° or less will not require the hydrostatic pressure test except as provided in paragraph (1). If the taper of the joint exceeds 10° and is not greater than 12°, its use will be permitted provided the joint will pass the 10 psi hydrostatic pressure test.

(e) Pipe for Type 2 joints shall have joints, which, when used with gasket material conforming to Subsection 1006.02(a) or (b), have been qualified by the Department's Materials Section and will pass the hydrostatic pressure test at a pressure of 5 psi.

(f) Pipe for Type 1 joints shall have joints qualified by the Department's Materials Section and shall use gasket material conforming to Subsection 1006.02(a), (b) or (c).

1006.05 PERFORATED CONCRETE PIPE. Perforated concrete pipe shall conform to ASTM Designation: C 444.

1006.06 CONCRETE DRAIN TILE. Concrete drain tile shall be of the class specified and shall conform to ASTM Designation: C 412.

1006.07 POROUS CONCRETE PIPE. Porous concrete pipe shall conform to AASHTO Designation: M 176.

1006.08 REINFORCED CONCRETE PIPE (Vitrified Clay Lined). Design for fully lined or half lined pipes of the specified strength and class shall be submitted by the manufacturer for approval.

The requirements of Subsection 1006.04 and AASHTO Designation: M 65 shall govern. Liner or liner element shall be clay of first quality, sound, thoroughly and perfectly burned, without warps or cracks or other imperfections, and fully and smoothly salt glazed.

1006.09 CLAY DRAIN TILE. Clay drain tile shall be of the class specified and shall conform to ASTM Designation: C 4.

1006.10 CLAY SEWER PIPE (Standard Strength). Standard strength clay sewer pipe shall conform to ASTM Designation: C 700.

1006.11 CLAY PIPE (Extra Strength). Extra strength clay pipe shall conform to ASTM Designation: C 700.

1006.12 PERFORATED CLAY PIPE (Standard and Extra Strength). Perforated clay pipe shall be of the strength class specified (standard strength or extra strength) and shall conform to ASTM Designation: C 700.

1006.13 VITRIFIED CLAY PIPE JOINTS USING MATERIALS HAVING RESILIENT PROPERTIES. Vitrified clay pipe having joints manufactured with resilient type jointing materials shall conform to ASTM Designation: C 425. The manufacturer shall supply certified test reports covering the jointing materials, when tested according to ASTM Designation: D 543.

1006.14 ASBESTOS-CEMENT, NON-PRESSURE SEWER PIPE. Asbestos-cement, non-pressure sewer pipe shall be of the class specified and shall conform to ASTM Designation: C 428.

1006.15 ASBESTOS-CEMENT PERFORATED PIPE. Asbestos-cement perforated pipe shall conform to AASHTO Designation: M 189.

1006.16 RUBBER RINGS FOR ASBESTOS-CEMENT PIPE. Rubber or synthetic rubber rings used for coupling asbestos-cement pipe shall be of the type specified and shall conform to ASTM Designation: D 1869.

The manufacturer shall supply the Department with certified test reports covering the rubber or synthetic rubber rings.

1006.17 HOMOGENEOUS BITUMINIZED FIBER DRAIN AND SEWER PIPE. This pipe shall conform to ASTM Designation: D 1861.

1006.18 LAMINATED-WALL, BITUMINIZED FIBER DRAIN AND SEWER PIPE. This pipe shall conform to ASTM Designation: D 1862.

1006.19 PERFORATED BITUMINIZED FIBER PIPE. This pipe shall conform to AASHTO Designation: M 177. Unless otherwise specified, either Type BJ or Type TJ coupling may be furnished.

1006.20 REINFORCED CONCRETE ARCH CULVERT, STORM DRAIN AND SEWER PIPE. These specifications cover reinforced arch-

shaped concrete pipe of sizes equivalent to 18 to 108 inch circular concrete pipe.

The pipe shall be of the class specified and shall conform to ASTM Designation: C 506, amended as follows:

(a) The geometric shape, wall thickness and reinforcement shall be in accordance with these specifications, and no modified or special designs will be allowed.

(b) Basis of Acceptance is expanded to include the following. Random testing, as established by Departmental policy, will be made to assure proper placement of reinforcing steel.

(c) Single line cage reinforcing will be allowed for equivalent diameter pipe 15 through 24 inches. All other pipe arch sizes and types will require double line cage reinforcing.

(d) The producer shall provide detailed fabrication drawings reflecting the requirements of these specifications prior to pipe inspection.

(e) Pipe for Type 3 joints shall have joints conforming to Subsection 1006.04(d).

(f) Pipe for Type 2 joints shall have joints conforming to Subsection 1006.04(e).

(g) Pipe for Type 1 joints shall have joints conforming to Subsection 1006.04(f).

1006.21 PLASTIC PIPE FOR UNDERDRAIN. Plastic pipe for underdrains shall be slot-perforated or nonperforated, as specified, conforming to one of the following types.

(a) **Corrugated Polyethylene (PE):** AASHTO Designation: M 252.

(b) **Polyvinyl Chloride (PVC):** ASTM Designation: D 3034.

Section 1007

Metal Pipe

1007.01 COUPLING BANDS. Coupling bands for joining metal conduit shall conform to AASHTO Designation: M 36 for steel conduit and AASHTO Designation: M 196 for aluminum conduit. For Type 2 joints, refer to Subsections 701.06(c) and 1007.02.

1007.02 TYPE 2 JOINTS. When Type 2 joints are specified for circular metal pipe, the joining system shall pass a 5 psi hydrostatic pressure test. When Type 2 joints are specified for metal pipe arch, due to allowable dimensional tolerances, a visual evaluation and field qualification of the joining system will be made in lieu of the hydrostatic pressure test. The gaskets shall conform to Subsection 1006.02(b) and shall be used with connections conforming to Subsection 1007.01. Other joining systems may be approved provided the system will pass the 5 psi hydrostatic pressure test and if the gasket material is approved by the Materials Section.

1007.03 CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits and coupling bands shall conform to the requirements of Type I (culvert pipes, circular section) and Type II (culvert pipes, other than circular section) of AASHTO Designation: M 36 amended as follows:

(a) Helical pipe to be joined shall have either helical or annular ends, and joining shall be made with approved coupling bands. Pipe with annular ends shall have the exposed ends of seams spot welded.

(b) The minimum sheet thickness shall be in accordance with Subsection 701.02; however, sheets thicker than that specified will be acceptable when approved by the engineer.

(c) Special sections, such as elbows and flared end sections shall be of the same sheet thickness as the pipe or pipe arch to which they are joined and shall conform to the applicable requirements of these specifications.

(d) Shop-formed elliptical pipe and shop-strutted pipe shall be furnished when specified.

(e) When "smooth lined" pipe is specified, the inside circumference of the pipe shall be fully lined with bituminous material in accordance with AASHTO Designation: M 190, Type D.

(f) When paved invert pipe is specified the invert shall be paved with bituminous material in accordance with AASHTO Designation: M 190, Type C.

1007.04 BITUMINOUS COATED CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits and coupling bands shall conform to AASHTO Designation: M 190 amended as follows:

(a) AASHTO Designation: M 36 is amended in accordance with Subsection 1007.03.

(b) The coating shall be Type A, fully bituminous coated unless otherwise specified.

1007.05 ASBESTOS BONDED CORRUGATED STEEL PIPE AND PIPE ARCH. Asbestos bonded corrugated steel pipe shall be fabricated from asbestos bonded sheets. The base metal and the fabrication of conduits and coupling bands shall conform to Subsection 1007.03.

The steel sheets shall be coated on both sides with a layer of asbestos fibers applied by pressing a sheet of asbestos fiber into the molten metallic bonding medium. Immediately after the metallic bond has solidified, the asbestos fibers shall be thoroughly impregnated with a bituminous saturant. The finished sheets shall be of first-class commercial quality, free from blisters and unsaturated spots.

After fabrication, the asbestos bonded pipe and pipe arch shall be fully bituminous coated with a Type A coating in accordance with AASHTO Designation: M 190. Smooth lined pipe shall be coated in accordance with Subsection 1007.03(e). Paved invert pipe shall be coated in accordance with Subsection 1007.03(f).

The helical fabrication process is not allowed for asbestos bonded corrugated steel pipe and pipe arch.

1007.06 CORRUGATED STEEL PIPE FOR UNDERDRAIN. This pipe shall conform to the requirements of Type III (underdrain pipes) of AASHTO Designation: M 36. Unless otherwise specified, any of the 4 classes may be furnished.

1007.07 BITUMINOUS COATED CORRUGATED STEEL PIPE FOR UNDERDRAIN. This pipe shall conform to the requirements of Type III (underdrain pipes) of AASHTO Designation: M 36 as amended by Subsection 1007.06 and shall be coated with bituminous material in accordance with AASHTO Designation: M 190, Type A coating, except that minimum coating thickness shall be 0.03 inch. Coupling bands shall be fully coated. The specified minimum diameter of perforations shall apply after coating.

1007.08 STRUCTURAL PLATE FOR PIPE, PIPE ARCH AND ARCH. This material shall conform to AASHTO Designation: M 167.

1007.09 CORRUGATED ALUMINUM PIPE AND PIPE ARCH.

These conduits shall conform to AASHTO Designation: M 196 with the following exceptions.

(a) Helical pipe to be joined shall have either helical or annular ends, and joining shall be made with approved coupling bands. Pipe with annular ends shall have the exposed ends of seams spot welded.

(b) Smooth lined pipe shall be coated in accordance with Subsection 1007.03(e). Paved invert pipe shall be coated in accordance with Subsection 1007.03(f).

1007.10 CORRUGATED ALUMINUM PIPE FOR UNDERDRAIN. This pipe shall conform to AASHTO Designation: M 196, Type III. Unless otherwise specified, any of the 4 classes may be furnished.

1007.11 SLOTTED DRAIN PIPE. Slotted drain pipe shall be asbestos bonded steel pipe conforming to Subsection 1007.05 and the following requirements.

(a) The slot details shall be as shown on the plans.

(b) Grate assemblies shall be made for structural steel suitably welded to form the open slot and galvanized in accordance with ASTM Designation: A 123.

(c) Grate assemblies shall be coated with bituminous material conforming to AASHTO Designation: M 190.

(d) Tees and elbows shall be shop welded and coated after fabrication.

(e) Joints shall conform to Subsection 1007.02.

1007.12 CAST IRON PIPE FOR CULVERTS. This pipe shall conform to ASTM Designation: A 142, for the specified strength classes. Unless otherwise specified, either smooth, corrugated or ribbed pipe may be furnished. Pipe of diameter in excess of 48 inches shall conform to the ANSI Designation: A 21.6 or A 21.8.

1007.13 CAST IRON PRESSURE PIPE. Cast iron pressure pipe suitable for carrying gas, water and other liquids under pressure shall conform to ASTM Designation: A 377.

1007.14 CAST IRON SOIL PIPE AND FITTINGS. Cast iron soil pipe and fittings shall conform to ASTM Designation: A 74.

1007.15 BLACK AND HOT-DIPPED ZINC-COATED (GALVANIZED) WELDED AND SEAMLESS STEEL PIPE FOR ORDINARY USES. Steel pipe for ordinary uses shall conform to ASTM Designation: A 120.

1007.16 WELDED AND SEAMLESS STEEL PIPE PILES. Pipe piles shall conform to ASTM Designation: A 252, Grade 2.

Section 1008

Paints

1008.01 GENERAL.

(a) Packaging: All paints covered by these specifications shall be delivered in containers not larger than 5-gallon capacity, unless otherwise specified. Used containers will not be permitted unless they have been reconditioned and thoroughly cleaned.

(b) Identification: Each paint container shall bear a label with the following information thereon: name and address of the manufacturer, trade name or trade mark, kind of paint, number of gallons, batch number, purchaser's order number and project number.

(c) Sampling: All sampling shall be in accordance with the Department's Materials Sampling Manual. Acceptance or rejection of shipments of paint will be based on the analyses of these samples.

1008.02 ORGANIC ZINC PRIMER AND TOPCOAT SYSTEMS. This coating system shall conform to DOTD Designation: TR 1011, Paragraph 3(a), Salt Fog Exposure, and Paragraph 3(b) Weatherometer Exposure, and other current test procedures of the Department. Upon successful completion of qualification testing, the system will be placed on the Department's Qualified Products List.

1008.03 INORGANIC ZINC PRIMER AND TOPCOAT SYSTEMS. This coating system shall conform to DOTD Designation: TR 1011, Paragraph 3(a), Salt Fog Exposure, and Paragraph 3(b), Weatherometer Exposure, and other current test procedures of the Department. Upon successful completion of qualification testing, the system will be placed on the Department's Qualified Products List.

1008.04 BASIC LEAD SILICO-CHROMATE PAINT.

(a) Description: These specifications set forth material requirements for basic lead silico-chromate paint to be used in a 3- or 4-coat paint system ovér properly prepared steel surfaces to be permanently exposed. The 4-coat paint system will use 1st, 2nd, 3rd and 4th coats of paint, and the 3-coat system will use only 1st, 3rd and 4th coats of paint as specified herein.

The shop coat (prime coat) for structural steel on new construction shall be in accordance with the requiremets of A(1).

The first prime coat for existing steel structures shall be in accordance with the requirements of A(2), unless otherwise specified.

The final field coat (4th coat) shall meet the requirements of D(2) "Cement Gray Paint."

(b) Requirements:

A(1). First Coat Basic Lead Silico-Chromate Brown Paint (Shop prime coat or first prime coat for steel on new construction):

a. Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	93.2	.....
Siliceous Red Iron Oxide (85% Fe_2O_3)	5.0	6.1
*Organo Montmorillonite	0.5	0.7

*Bentone 38

b. Liquid: The liquid shall consist of not less than 52 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in the approximate proportions of 1:1 by weight and shall contain a minimum of 15 percent phthalic anhydride. The alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type III. Small quantities of grinding and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	57.0%	.....
Vehicle	.....	43.0%
Weight/Gallon, Pounds @ 77°F	13.5	.....
Water	.....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	4	.....
Viscosity (Stormer-Krebs Units) @ 77°F	72	83
Drying Time:		
Set to Touch, Hours	.....	4
Dry Through, Hours	.....	16

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—58.4% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	93.5
Siliceous Red Iron Oxide (85% Fe_2O_3)	5.9
*Organo Montmorillonite	0.6
	100.0

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—41.6% by Weight	
Raw Linseed Oil (AASHTO Designation: M 125-60)	26.7
Alkyd Resin (TT-R-266, Type III)	52.3
Mineral Spirits	18.7
6% Zirconium Catalyst	1.2
6% Manganese Naphthenate	0.4
6% Cobalt Naphthenate	0.2
Anti-Skinning Agent	0.2
Methyl Alcohol:Water (95:5)	0.3
	100.0

PV (% pigment by volume in nonvolatile portion of paint): 39.7

Volatile and drier in vehicle: 44.9%

A(2). First Coat Basic Lead Silico-Chromate Brown Paint (First prime coat for existing steel structures and maintenance painting):

a. Pigment: The pigment shall be well ground and composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	94.0	.....
Siliceous Red Iron Oxide (85% Fe_2O_3)	4.0	5.5
*Organo Montmorillonite	0.5	0.7

*Bentone 38

b. Liquid: The liquid shall consist of not less than 69 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in the approximate proportions of 2.3:1 respectively by weight and shall contain a minimum of 7.0 percent phthalic anhydride. The alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. A drier combination of 0.14 percent

zirconium, 0.04 percent manganese, and 0.02 percent cobalt metals furnished in soluble form based on the nonvolatile vehicle of the paint shall be used. Small quantities of grinding and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	64.0%	.....
Vehicle	.....	36.0%
Weight/Gallon, Pounds @ 77°F	15.0	.....
Water	.....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	4	.....
Viscosity (Stormer-Krebs Units) @ 77°F	72	80
Dry Firm, Hours	18	.....

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—64.58% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	94.43
Siliceous Red Iron Oxide (85% Fe_2O_3)	4.97
*Organo Montmorillonite	0.60
	100.00

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—35.42% by Weight	
Raw Linseed Oil (AASHTO Designation: M 125-60)	48.46
Alkyd Resin (TT-R-266, Type I, Class A)	30.81
Mineral Spirits	17.94
6% Zirconium Catalyst	1.58
6% Manganese Naphthenate	0.47
6% Cobalt Naphthenate	0.24
Anti-Skinning Agent	0.18
Methyl Alcohol:Water (95:5)	0.32
	100.00

PV (% of pigment by volume in nonvolatile portion of paint): 38.1
Volatile and drier in vehicle: 29.9%

B. Second Coat Basic Lead Silico-Chromate Maroon Paint:

a. Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	64.0	.....
Siliceous Red Iron Oxide (85% Fe_2O_3)	.....	35.5
*Organo Montmorillonite	0.5	0.7

*Bentone 38

b. Liquid: The liquid shall consist of not less than 72 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in the approximate proportions of 2:1 respectively by weight and shall contain a minimum of 7.6 percent phthalic anhydride. The alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. A drier combination of 0.14 percent zirconium and 0.04 percent manganese metals furnished in soluble form based on the nonvolatile vehicle of the paint shall be used. Small quantities of grinding and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	62.0%	.....
Vehicle	.....	38.0%
Weight/Gallon, Pounds @ 77°F	14.8	.....
Water	.....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	4	.....
Viscosity (Stormer-Krebs Units) @ 77°F	74	84
Dry Firm, Hours	18	.....

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—62.26% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	64.62
Siliceous Red Iron Oxide (85% Fe_2O_3)	34.79

	% By Weight
*Organo Montmorillonite	0.59
	100.00

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—37.74% by Weight

Raw Linseed Oil (AASHTO Designation: M 125-60)	47.56
Alkyd Resin (TT-R-266, Type I, Class A)	34.44
Mineral Spirits (Hv)	14.76
Anti-Skinning Agent	0.16
6% Zirconium Catalyst	1.80
6% Manganese Naphthenate	0.49
Methyl Alcohol:Water (95:5)	0.30
Soya Lecithin	0.49
	100.00

PV (% pigment by volume in nonvolatile portion of paint): 34.8

Volatile and drier in vehicle: 27.84%

C. Third Coat Basic Lead Silico-Chromate Gray Paint:

a. Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	65.6	.....
Chalk Resistant Rutile Titanium Dioxide	.....	16.6
Acicular Zinc Oxide	.....	5.8
Fibrous Magnesium Silicate and Tinting Colors (Lampblack and Phthalocyanine Blue) No Iron Blue Permitted	.....	11.5
*Organo Montmorillonite	0.5	.....

*Bentone 38

b. Liquid: The liquid shall consist of not less than 69 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in the approximate proportions of 2:1 respectively by weight and shall contain a minimum of 7.5 percent phthalic anhydride. The alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. Small quantities of grinding and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	56.5%	.....
Vehicle	.....	43.5%
Weight/Gallon, Pounds @ 77°F	13.5	.....
Water	.....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	4	.....
Viscosity (Stormer-Krebs Units) @ 77°F	72	82
Dry Firm, Hours	18	.....

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—57.7% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	67.80
Titanox RANC	15.52
Zinc Oxide	5.13
Magnesium Silicate	9.77
Lampblack	0.81
Phthalocyanine Blue	0.36
*Organo Montmorillonite	0.61
	100.00

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—42.3% by Weight	
Raw Linseed Oil (AASHTO Designation: M 125-60)	46.83
Alkyd Resin (TT-R-266, Type I, Class A)	33.33
Mineral Spirits	18.00
6% Zirconium Catalyst	1.17
6% Manganese Naphthenate	0.23
Anti-Skinning Agent	0.16
Methyl Alcohol:Water (95:5)	0.28
	100.00

PV (% pigment by volume in nonvolatile portion of paint): 32.5

Volatile and drier in vehicle: 30%

D(1). Fourth Coat Basic Lead Silico-Chromate (Bright Green Paint):

a. Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	64	.....
Titanium Dioxide, Rutile Nonchalking	18	.....
Tinting Colors (C.P. Chrome Yellow Light Phthalocyanine Green)	Balance	
*Organo Montmorillonite	0.8	1.0

*Bentone 38

b. Liquid: The liquid shall consist of not less than 47.0 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be an alkyd resin conforming to Federal Specification TT-R-266, Type I, Class A or B. The thinner shall be essentially mineral spirits conforming to Federal Specification TT-T-291a, Grade 1. Small quantities of grind and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	30.5%	.....
Vehicle	.....	69.5%
Weight/Gallon, Pounds	9.8	.....
Water	.....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	5	.....
Viscosity (Stormer-Krebs Units)	65	75
Dry Firm, Hours	.....	8

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—31.0% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	64.2
Titanox RANC	18.4
Chrome Yellow, Light	11.0

	% By Weight
Phthalocyanine Green	5.5
*Organo Montmorillonite	0.9
	100.0

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—69.0% by Weight	
Alkyd Resin (TT-R-266, Type I, Class A)	67.2
Mineral Spirits	30.7
Zirconium Catalyst, 6%	1.2
Cobalt Naphthenate, 6%	0.3
Manganese Naphthenate, 6%	0.3
Anti-Skinning Agent	0.2
Methyl Alcohol:Water (95:5)	0.1
	100.0

PV (% pigment by volume in nonvolatile portion of paint): 20.1

Volatile and drier in vehicle: 53.0%

D(2). Fourth Coat Basic Lead Silico-Chromate (Cement Gray Paint):

a. Pigment: The pigment shall be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	39.0	.....
Titanium Dioxide, Rutile Nonchalking	57.0	.....
Phthalocyanine Blue and Lampblack	Balance	
*Organo Montmorillonite	0.7	0.9

*Bentone 38

b. Liquid: The liquid shall consist of not less than 50 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be an alkyd resin conforming to Federal Specification TT-R-266, Type I, Class A or B. The thinner shall be essentially mineral spirits conforming to Federal Specification TT-T-291a, Grade 1. Small quantities of grind and wetting aids may be used if desired.

c. The paint shall consist of:

	Min.	Max.
Pigment	33.0%	.....
Vehicle	.....	67.0%
Weight/Gallon, Pounds @ 77°F	10.0	.....
Water	.....	0.5%

	Min.	Max.
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	.....	1.0%
Fineness of Grind (North Standard)	5	.....
Viscosity (Stormer-Krebs Units) @ 77°F	68	75
Dry Firm, Hours	.....	8

The material which follows is a suggested batching formulation that will conform to the prior stated composition.

	% By Weight
Pigment—33.6% by Weight	
Basic Lead Silico-Chromate (ASTM Designation: D 1648)	39.10
Titanox RANC	58.66
*Organo Montmorillonite	0.84
Phthalocyanine Blue	1.40
	100.00

* Pre-wet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

Vehicle—66.4% by Weight	
Alkyd Resin (TT-R-266, Type I, Class A)	71.9
Mineral Spirits (AASHTO Designation: M 128-60)	24.9
6% Zirconium Catalyst	1.4
6% Cobalt Naphthenate	0.3
6% Manganese Naphthenate	0.3
Anti-Skinning Agent	0.2
Methyl Alcohol:Water (95:5)	1.0
	100.0

PV (% pigment by volume in nonvolatile portion of paint): 20.8

Volatile and drier in vehicle: 49.1%

E. Application: Coating must be capable of being applied to the required film thickness by brush, roller or spray application methods without difficulty at temperatures above 40°F and shall exhibit no running, streaking, sagging, wrinkling or other film defects.

F. Color: The color shall be as specified for the paint of a particular coat. Color chips are available upon request from the Department's Materials Laboratory.

G. Hiding Power: Shall be sufficient to obtain complete hiding when applied at normal spreading rates.

H. Packaging and Storage: The material shall be shipped in 5-gallon, full lid, metal containers meeting the latest requirements of the Interstate Commerce Commission for shipping containers for materials, unless other size containers are specified. The containers shall have appropriate descriptive labels with necessary instructional information.

After one year storage the material shall show neither skinning, settling, color change nor thickening or livering that cannot be readily brought to stable consistency by normal mixing procedures.

1008.05 RED LEAD PAINT. Red lead paint shall conform to AASHTO Designation: M 72, Type II, except that the first field coat shall be tinted with one ounce of lampblack, paste form, to one gallon of finished paint. The lampblack shall be incorporated by the manufacturer.

1008.06 WHITE READY-MIX PAINT. White paint shall conform to AASHTO Designation: M 70, Type I, Class A.

1008.07 ALUMINUM PAINT. Aluminum paint shall conform to AASHTO Designation: M 69, Type I.

1008.08 FOLIAGE GREEN BRIDGE PAINT. This paint shall conform to AASHTO Designation: M 67, Type I.

1008.09 BLACK BRIDGE PAINT. This paint shall conform to AASHTO Designation: M 68.

1008.10 LAMPBLACK. This material shall conform to ASTM Designation: D 209.

1008.11 PROTECTIVE COATING.

(a) Protective Coating — Nonemulsified Type:

(1) General Requirements: This is a black, self-priming, heavy duty protective coating suitable for use when unusually severe corrosive conditions are encountered. As received, it is a heavy paste or plastic-like material; however, on stirring it thins out to brushing or spraying consistency without the use of thinners of any kind. On standing after stirring, it returns to its original pastelike state. It can be applied to steel, concrete or masonry surfaces in exceptionally thick films without sag.

(2) Composition: Nonemulsified type coating is composed of a tar base pitch blended with selected solvents to a heavy paste-like consistency. Natural asphalt or petroleum shall not be used as one of the constituents.

(3) Specifications: This material shall conform to the following requirements:

Test	Requirement	Test Method
1. Sag Test	No Sag	Applied at a rate of 60 sq. ft. per gallon to a smooth metal surface.

Test	Requirement	Test Method
2. Ash, % by weight	15-25	Ignition
3. Distillation % by wt.		ASTM D 20
0-150°C (302°F)	0	
0-235°C (455°F)	20-30	
Distillation Residue		
Softening Point, °F	205-240	ASTM D 36
Penetration at 77°F 100g, 5 Sec.	5-25	ASTM D 5

(4) Surface preparation and rate of application shall be in accordance with the manufacturer's recommendations.

(b) Protective Coating — Emulsified Type:

(1) General Requirements: This is a thick, heavy duty, cold applied, protective coating of the water emulsion type. It may be applied to metal or concrete surfaces by means of brush, roller or suitable spray equipment. The coating must be applied heavily in all cases and multiple coats are desirable. It may only be applied at atmospheric temperatures in excess of 45°F and in dry weather. This type can be successfully applied over the nonemulsified type which has thoroughly dried.

(2) Composition: Emulsified type coating is comprised of an aromatic hydrocarbon base derived from coal tar and inert mineral filler dispersed in water to produce a stable colloidal suspension. It contains no volatile solvent or asphalt, either petroleum or natural. The winter grade, however, contains an antifreeze to stabilize the emulsion during cold weather shipment and should be applied in enclosed areas only with adequate ventilation.

(3) Specifications: This material shall conform to the following requirements:

Test	Requirement	Test Method
1. Consistency	Smooth, homogeneous paste suitable for brush, roller or spray application.	Visual Examination.
2. Weight per gallon, pounds	9.5-10.5	Weighing Cup
3. Ash, % by weight	15-25	Ignition
4. Water, % by weight, Maximum	50 50	AASHTO T 55
5. Sag Test	No Sag	50 sq. ft. per gal. on a vertical, smooth, primed metal surface.

(4) Surface preparation and rate of application shall be in accordance with the manufacturer's recommendations.

1008.12 ASPHALTIC VARNISH.

(a) **Material:** Asphaltic varnish shall be composed of hard native asphalts or asphaltites (gilsonite for example), run (fluxed) and blended with properly treated drying oils, and thinned for suitable solvents together with the necessary amount of drier.

(b) **Appearance:** The film shall be smooth and homogeneous when examined by pouring some of the thoroughly mixed sample on a clean, clear, glass plate and standing in a vertical position until the excess varnish has drained off. Examine the film by transmitted light.

(c) **Color:** The color shall be jet black when examined by rejected light.

(d) **Nonvolatile Matter:** The nonvolatile matter shall be not less than 40 percent by weight.

(e) **Drying of film:**

(1) **Set to Touch:** The film shall set to touch in not more than 8 hours.

(2) **Dry Firm:** The film shall be dry firm in not more than 36 hours.

(f) **Working Properties and Appearance of Dried Film:** The varnish shall have good brushing, flowing, covering and leveling properties. The dried film shall be jet black, smooth and free from brush marks, blisters, pinholes and other defects

(g) **Water Resistance:** The film shall show no whitening, dulling or other defects after a dried film is immersed in water for 18 hours and air dried for 2 hours.

1008.13 COAL TAR EPOXY-POLYAMIDE PAINT. This paint shall conform to Corps of Engineers Specification CE-1409, Formula C-200.

Section 1009

Reinforcing Steel and Wire Rope

1009.01 REINFORCING STEEL. Reinforcing steel for concrete reinforcement shall conform to the following specifications.

(a) Billet-Steel Deformed and Plain Bars, ASTM Designation: A 615.

(b) Rail-Steel Deformed and Plain Bars, ASTM Designation: A 616.

(c) Axle-Steel Deformed and Plain Bars, ASTM Designation: A 617.

(d) Cold-Drawn Steel Wire, ASTM Designation: A 82 with the following amendment: For material testing over 110,000 psi tensile strength in high strength applications such as spirals and ties, the 25 percent minimum reduction in area shall be reduced 5 percent for each 10,000 minimum psi increment of tensile strength exceeding 110,000 psi; there shall be no requirement for determination of yield strength.

(e) Fabricated Steel Bar Mats, ASTM Designation: A 184.

(f) Welded Steel Wire Fabric, ASTM Designation: A 185.

(g) No. 2 bars, need not be deformed, and shall conform to Headings (a), (b) or (c) above. Wire conforming to Heading (d) above may be used in lieu of No. 2 bars when furnished in size W 5.

1009.02 SPIRAL REINFORCING. Spiral reinforcing shall conform to ASTM Designations: A 615, A 616, A 617 or ASTM Designation: A 82 as amended in Subsection 1009.01.

1009.03 TIE BARS. Tie bars shall conform to ASTM Designations: A 615, A 616 or A 617. Tie bars that are to be bent and restraightened during construction shall be Grade 40.

1009.04 LOAD TRANSMISSION DEVICES.

(a) Dowel Bars: Dowel bars shall be plain round bars conforming to ASTM Designations: A 615, A 616 or A 617. The sleeves for dowel bars shall be of an approved material and design to cover 2 inches of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 1 inch from the end of the dowel bar.

Paint to be used for painting dowel bars shall conform to AASHTO Designation: M 72.

Plastic coated dowel bars shall be undercoated with an adhesive and then given a final outer coat of extruded polyethylene plastic in accordance with the following requirements.

Undercoating:

Color	Black
Adhesive Material	Modified Rubber Blend
Adhesive Thickness	1 to 8 mils (4 mils nominal)
Total Thickness Outer and Undercoatings	21 mils nominal
Tensile Strength Min., 2″/Min.	3,000 psi
Elongation, Minimum	100%
Water Vapor Transmission Rate	0.0001 Gr./24H./100 in.^{2}
Moisture Absorption	0.01%
Penetration, 200 psi Load, ¼ in. Blunt Rod	Negligible
Tear Resistance	Very High
Abrasion Resistance	Excellent
Operating Temperature Range	−40° to 150°F

Outer Coating:

Color	Opaque Yellow
Coating Material	High Density Polyethylene
Coating Thickness	10 to 20 mils (17 mils nominal)

(b) Cantilever Devices: Cantilever type devices shall be fabricated of cast malleable iron conforming to details shown on the plans. The castings forming each of the 2 sections shall be of material conforming to ASTM Designation: A 47, Grade No. 35018. Each load transmission unit of the cantilever type shall consist of 2 identical castings providing a cantilever arm on which the other half of the unit shall bear, and each casting shall have an upper tension anchor and a lower compression anchor, all constructed in accordance with the general dimensions shown on the plans. The castings shall be cleaned and ground as necessary in order that each may be in conformity with the required dimensions and assembled into a complete unit providing coincidence of bearing on both the vertical and horizontal sliding faces. The castings shall be sufficiently smooth so that there will be no interference with smooth sliding operation.

1009.05 STEEL STRAND FOR PRETENSIONING. Strand for pretensioning shall conform to ASTM Designation: A 416. The strand manufacturer shall submit to the Department's Construction Section 3 copies of certificates of anaylsis of all test results as stipulated in ASTM Designation: A 416, and as part of this document, shall provide the modulus of elasticity of that particular mill heat of strand. The Department reserves the right to conduct inspections at the site of manufacture and to have all tests witnessed by its inspector.

1009.06 BARS FOR POST-TENSIONING. Bars shall be high tensile strength steel. They shall be equipped with wedge type end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area.

The physical properties of the bar steel and the stress-strain curve determined by static tensile test shall conform to the following:

Ultimate Stress	145,000 psi minimum
Stress at 0.7% Elongation	130,000 psi minimum
Elongation in 20 Diameters	4% minimum
Modulus of Elasticity	25,000,000 minimum
Diameter Tolerance	+ 0.03 inch or − 0.01 inch

1009.07 PARALLEL WIRE ASSEMBLIES FOR POST-TENSION. Assemblies shall consist of parallel wire of the number and size as shown on the plans. Wire shall be high tensile, hard-drawn, stress-relieved and uncoated, delivered in coils of 54 inches minimum diameter. The wire shall conform to ASTM Designation: A 421, Type WA.

1009.08 ANCHORAGES FOR POST-TENSIONED TENDONS.

(a) For Bars: Wedge type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot-rolled steel having characteristics not less than as specified for No. 1040 of the AISI Specifications.

(b) For Parallel Wire Assemblies: Wedge type anchorages of the sandwich plate or conical type shall generally be used. The anchorage device shall be capable of developing the ultimate strength of the total number of wires anchored. Conical type anchorages shall be embedded within the ends of the concrete members, unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

(c) Alternate Anchorage Types: Alternate anchorage types conforming to the general physical requirements specified above for wedge type anchorages will be considered. All anchorage types either will be required to develop the specified ultimate strength of the reinforcing tendons, or the allowable stress on the tendon will be based on anchorage strength.

Any alternate type anchorage considered will be required to show evidence of being capable of withstanding at least 3,000,000 cycles of twice the maximum live load stress variation.

1009.09 ANCHORAGES AND HARDWARE FOR PRETENSIONING. Anchorages including holddown and miscellaneous hardware shall be sampled in accordance with the Department's Materials Sampling Manual and submitted to the Department's Construction Section for approval by evaluation or testing.

1009.10 WIRE ROPE. Unless otherwise specified all wire rope shall conform in general to Federal Specifications RR-W-410C and the following specific requirements.

Wire rope shall be improved plow steel, uncoated; preformed; 6 x 19 filler wire construction with hard fiber core; and right regular lay.

All fiber cores shall be prelubricated by the cordage manufacturer. All component parts of the wire rope, fiber cores, wires and strands shall be lubricated during fabrication with an approved lubricant containing a rust inhibitor.

(a) Type and Classification: The Type and Classification of wire rope shall conform to one shown in Table II.

(b) Breaking Strength and Dimensions: Unless otherwise specified, the diameter, circumference, pitch and breaking strength shall be as specified in Table II. For other types and classifications refer to Federal Specifications RR-W-410C.

Should the breaking strength of the wire fall below the values specified in Table III, the entire length from which the test pieces were taken shall be replaced by the manufacturer with a new length, the strength and mechanical properties of which shall meet the specifications.

No splicing of wire rope or its component strands will be permitted. All wires in the wire rope shall be of continuous length.

When wire joints are necessary, they shall be electrically butt-welded; and in the stranding operation, no two joints in any one strand shall be closer than 25 feet apart, except for the filler wires.

Wire rope shall be shipped on reels, the minimum diameter of which shall be not less than 25 times the nominal diameter of the wire rope; if shipped in coils, the inside diameter of the coils shall be not less than 25 times the nominal diameter of the wire rope.

1009.11 COUNTERWEIGHT ROPES. Every effort shall be made to fabricate wire ropes of uniform physical properties, and counterweight wire ropes operating as a group in one equalizing system shall be cut from one continuous manufactured length.

Wire rope furnished shall be prestressed and measured for length by the manufacturer prior to delivery. The contractor shall notify the engineer at least 10 calendar days in advance of prestressing operations so that the Department may have its inspector present for the said operations.

Counterweight ropes shall be prestressed, and the prestressing load shall be 35 percent of the listed breaking strengths of the wire ropes, and such loading shall be applied 3 times to the wire ropes. The cycle of loading shall be between the limits of 5 percent to 35 percent, and the maximum loadings shall be held on the wire rope for a period of 15 minutes each.

TABLE II

General Wire Rope Classification and Usage

Type	Classification	Usage
I	1. (6 x 7)	Haulage rope, for use where strength and durability are desirable, but not much bending is required. May be used as single line for pulling load, but not suitable for sheave work.
	2. (6 x 19)	Most widely used for cranes, derricks, dredges, draglines and scrapers. This classification is very rugged, withstands abrasion well and is generally suited for all-around use.
	3. (6 x 37)	For hoisting rope where maximum flexibility is required; for instance, hoisting rope on dragline that runs over small sheave.
II	2. (8 x 19)	High speed elevator rope.
III (Marine)	1. (6 x 6)	Deck lashing ropes.
	2. (6 x 12)	Running ropes.
	3. (6 x 24)	Mooring lines.
	4. (6 x 3 x 7)	Spring lay.
	5. (6 x 3 x 19)	Spring lay.
	6. (6 x 42)	Tiller or hand control rope.
IV (Special)	2. (18 x 7)	Nonrotating (for drill rigs).

The length of each wire rope from centerline of open socket pins or from the bearing of closed sockets shall be measured under a tension of 12 percent of the listed breaking strengths, and a metal tag having the said length stamped thereon shall be securely attached to the wire rope. The length of each rope shall also be stamped on each socket. After the wire rope has been measured as noted herein, it shall have a stripe painted on one side along its entire length to assure the twist of the wire rope during erection of the bridge. The rope number shall be stamped on each socket, counterweight and span lifting point.

The length of these wire ropes shall not vary from the specified length by more than plus or minus 0.0002 times the specified length.

All sockets and socket pins used in connection with wire ropes shall be forged, without welds, from solid steel and shall conform to ASTM Designation: A 668, Class D, normalized. The socket shall be attached to the wire rope by using zinc of a quality not less than defined for Intermediate Grade in

TABLE III

Type I, General Purpose, Class 2, 6 by 19, Improved Plow Steel, Fiber Core

Rope Diameter Nominal (ordered) (Minimum)	Maximum	Approximate Circumference	Maximum Strand Pitch		Approximate Weight	Minimum Breaking Strength on Bright (uncoated) Wire Ropes
			Regular Lay	Lang Lay		
Inches	Inches	Inches	Inches	Inches	Lbs./Ft.	Pounds
1/4	9/32	3/4	1-11/16	1-13/16	0.105	5343
5/16	11/32	1	2-1/8	2-9/32	.164	8307
3/8	13/32	1-1/8	2-17/32	2-23/32	.236	11895
7/16	15/32	1-3/8	2-31/32	3-3/16	.32	16127
1/2	17/32	1-5/8	3-3/8	3-5/8	.42	20865
9/16	19/32	1-3/4	3-13/16	4-3/32	.53	26325
5/8	21/32	2	4-7/32	4-17/32	.66	32565
3/4	25/32	2-3/8	5-1/16	5-7/16	.95	46410
7/8	59/64	2-3/4	5-29/32	6-11/32	1.29	62790
1	1-3/64	3-1/8	6-3/4	7-1/4	1.68	81510
1-1/8	1-11/64	3-1/2	7-19/32	8-5/32	2.13	102570
1-1/4	1-5/16	3-7/8	8-7/16	9-1/16	2.63	125970
1-3/8	1-7/16	4-3/8	9-9/32	9-31/32	3.18	151515
1-1/2	1-9/16	4-3/4	10-1/8	10-7/8	3.78	179400
1-5/8	1-23/32	5-1/8	10-31/32	11-25/32	4.44	208650
1-3/4	1-27/32	5-1/2	11-13/16	12-11/16	5.15	241800
1-7/8	1-31/32	5-7/8	12-21/32	13-19/32	5.91	274950
2	2-3/32	6-1/4	13-1/2	14-1/2	6.72	312000
2-1/8	2-7/32	6-5/8	14-11/32	15-13/32	7.59	349050
2-1/4	2-11/32	7-1/8	15-3/16	16-5/16	8.51	390000
2-1/2	2-5/8	7-7/8	16-7/8	18-1/8	10.5	475800
2-3/4	2-7/8	8-5/8	18-9/16	19-15/16	12.7	569400

ASTM Designation: B 6, and wire rope must not slip appreciably in its connection.

The movement of the zinc cone in the socket basket when the wire rope is stressed to 80 percent of the listed breaking strength shall not exceed 1/6 of the nominal diameter of the wire rope. If a greater movement should occur, the method of attachment shall be changed until a satisfactory one is found.

Full sized specimens of rope shall be fitted with sockets, attached not less than 25 rope diameters but not more than 12 feet apart, and shall be tested to destruction. The number of test specimens shall not exceed 10 percent of the total number of finished lengths of rope to be made, nor shall there be less than 2 specimens taken from each original length of rope.

The manufacturer shall provide proper facilities for making the tests and shall make them at his expense. The contractor shall furnish the engineer with certified test reports for all required tests.

If the physical properties of the rope or its individual wires fail to fulfill the specified requirements, the entire length from which the test pieces were taken shall be rejected and shall be replaced with a new length, the physical properties of which shall conform to those specified.

If a socket should break during the tests of the wire rope, 2 others shall be selected and attached to another piece of rope, and the test shall be repeated. This process shall be continued until the reliability of the sockets is established, in which case the lot shall be accepted. If, however, 10 percent or more of the sockets tested break at a load less than the specified minimum strength of the rope, the entire lot shall be rejected.

The engineer reserves the right to test each wire rope at his expense after the sockets are attached, by a load equal to one-half the listed breaking strength of the wire rope. If the assembly shows weakness, it shall be rejected and replaced.

Wire ropes shall be suitably marked or tagged for identification for proper erection.

The wire ropes shipped on reels shall be removed by revolving the reels, and wire ropes shipped in coils shall be mounted on a turntable for uncoiling. In uncoiling and in erecting, the wire ropes shall be carefully handled so as to avoid any kinks, sharp bends or twisting of the wire ropes.

1009.12 CONTINUOUS REINFORCEMENT. Continuous reinforcement shall consist of deformed steel reinforcing bars or prefabricated deformed wire mats meeting these requirements.

(a) Deformed Steel Bars: When deformed steel reinforcing bars conforming to ASTM Designation: A 615 are used for longitudinal or transverse members, the bending test requirements will not be required. Bars which are bent and later straightened to facilitate construction shall conform to ASTM Designation: A 615, Grade 40.

(1) Longitudinal Bars: Deformed steel bars for longitudinal reinforcement shall conform to one of the following ASTM Designations:

	ASTM Designation
Billet-Steel (Grade 60)	A 615
Rail-Steel (Grade 60)	A 616
Axle-Steel (Grade 60)	A 617

(2) Transverse Bars: Deformed steel bars for transverse reinforcement shall conform to one of the following ASTM Designations:

	ASTM Designation
Billet-Steel	A 615
Rail-Steel	A 616
Axle-Steel	A 617

(3) Bar Lengths: When reinforcement consists of loose bars assembled at the site, longitudinal bars shall be not less than 30 feet in length, except where shorter bars are required for starting or ending a specified staggered lap pattern or at a construction joint. The maximum length shall be that which, in the judgment of the engineer, can be handled and installed in a proper manner.

(b) Prefabricated Wire Mats: Prefabricated deformed wire mats shall conform to ASTM Designation: A 497, with deformed wire conforming to ASTM Designation: A 496 with 70,000 psi minimum yield strength in the welded form.

Tie bars and load transfer devices that require bending shall conform to ASTM Designation: A 615, Grade 40, or ASTM Designation: A 82 with 70,000 psi minumum yield strength, as modified by Subsection 1009.01(d).

Section 1010

Fence and Guard Rail

1010.01 BARBED WIRE. Barbed wire may be either steel or aluminum alloy conforming to the plans and the following requirements.

(a) General Requirements: The gage of the wire shall be as shown on the plans. The average spacing of the barbs based on a minimum sample length of 4 feet shall not exceed the specified nominal spacing, and no individual spacing shall vary from the nominal spacing by more than ¾ inch.

(b) Steel Barbed Wire: Steel barbed wire shall conform to ASTM Designation: A 121. The coating weight shall be Class 1 unless otherwise specified.

(c) Alluminum Alloy Barbed Wire: Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM Designation: B 211, Alloy 5052-0 for the line wire and Alloy 5052-H 38 for the barbs.

1010.02 WOVEN WIRE. Woven wire shall conform to ASTM Designation: A 116. The size of the woven wire shall be as shown on the plans, and the spelter coating shall be Class 1, unless otherwise specified.

1010.03 POSTS FOR FIELD AND LINE TYPE FENCE. Line posts may be either treated timber posts or steel posts, except as provided elsewhere herein; however, the same type of posts furnished for line posts shall be used throughout a section of fence. Bracing posts, end posts and corner posts may be either treated timber posts or steel posts, as the contractor elects.

(a) Treated Timber Posts: Posts shall be treated Southern Pine of the dimensions shown on the plans.

Posts shall be either round or sawed but all posts shall be the same. Posts and bracing shall be cut from sound and solid trees (not limbs) and shall contain no unsound knots. Sound knots will be permitted if the diameter of the knot does not exceed ⅓ the diameter of the piece at the point where it occurs. Posts and bracing shall be free from decayed wood, rot and red heart. Ring shakes and season checks which penetrate at any point more than 1/4 inch wide shall be cause for rejection. Posts and bracing shall show not less than 4 annual rings per inch and not less than 1/3 summer wood.

All posts shall be peeled for their full length and all bark and inner skin removed. Knots shall be trimmed close to the body of the post before treatment. A line drawn from center of top to center of butt shall not fall outside the body of the post nor at any point be more than 2 inches from the geometric center of the post. Posts and bracing shall be free from short or reverse bends. All butts and tips shall be sawed square.

All posts shall be air or artificially seasoned prior to treatment. After seasoning, posts shall be treated with one of the following preservatives at the contractor's option. The preservative material shall conform to Subsection 1014.03.

(1) Creosote treatment in accordance with Subsection 1014.04(a) and (b).

(2) Pentachlorophenol-Petroleum Solution treatment in accordance with Subsection 1014.04(a) and (b).

(3) Chromated Copper Arsenate-Type B treatment in accordance with Subsection 1014.04(a) and (b).

(b) Steel Fence Posts: Steel posts furnished for line, end, corner and bracing posts shall be one of the suggested types shown on the plans.

All steel posts shall be equipped with corrugations, knobs, notches, holes or studs so placed and constructed as to engage a substantial number of fence line wires in proper position. Posts may be punched with holes in such position and of such size as will not impair the strength of the posts. Posts with punched tabs used for fastening wires are not acceptable. Corner, end and bracing posts shall be supplied with necessary holes and with galvanized bolts of standard commercial quality or other satisfactory substitute, such as castings, for fastening braces to the posts.

Line posts and post assemblies shall be furnished in lengths shown on the plans and shall conform to ASTM Designation: A 702 except that a hardness test may not be substituted for the tensile test. Line posts shall be furnished with anchor plates of the approximate shape and dimensions shown on the plans and conforming to ASTM Designation: A 702. Steel posts, including anchor plates on line posts and braces, shall be galvanized in accordance with ASTM Designation: A 123.

Excessive bow, camber, twist or other injurious defects in posts shall be considered cause for rejection of such posts.

1010.04 BRACES FOR FENCING.

(a) Timber Braces: Timber braces shall be of the dimensions shown on the plans and shall be treated timber conforming to Subsection 1010.03(a), Treated Timber Posts.

(b) Steel Braces: Steel braces shall be of the approximate type and dimensions shown on the plans and shall conform to ASTM Designation:

A 702, galvanized in accordance with ASTM Designation: A 123.

1010.05 GATES (Roadside Fence).

(a) Gates: Design of metal gates shown on standard plans is a type acceptable to the Department.

If the contractor proposes to furnish gates of a design other than that shown on the plans, he shall submit to the Department for approval specifications covering the design and fabrication of the type gates he contemplates furnishing.

Gates shall be of the dimension and weight specified on the plans.

Steel sheets used in fabricating gates shall be galvanized in accordance with ASTM Designation: A 446, G 90 Coating Designation (1.25 Commercial).

(b) Posts:

(1) Treated Timber Posts: Treated timber posts shall conform to Subsection 1010.03(a)

(2) Metal Posts: Metal posts shall be made of galvanized steel pipe, standard weight, conforming to ASTM Designation: A 120.

(c) Hardware: Hinges, washers, nails, staples, well chains and latches shall be of standard quality satisfactory for use with the type of gate and posts selected for use and acceptable to the engineer.

(d) Gate Stops:

(1) Treated Timber Posts: The gate stop of the dimensions shown on the plans shall be treated timber conforming to Subsection 1010.03(a). Gate stops shall be treated in the same manner as specified for treated timber posts.

(2) Metal Posts: The gate stop shall be galvanized steel, suitable for welding to the post and acceptable to the engineer.

(e) Stop Posts: Stop posts furnished for double swinging driveway gates shall be of the dimensions shown on the plans and shall be treated timber conforming to Subsection 1010.03(a).

1010.06 STAPLES. Staples shall be made of galvanized steel wire and shall be of the size shown on the plans. The minimum spelter coating when tested by ASTM Designation: A 90 shall be 0.2 ounce per square foot.

1010.07 METAL FASTENERS FOR STEEL POSTS. Metal fasteners for steel posts shall be galvanized steel wire fasteners or clamps and shall be satisfactory for use with the type of steel post furnished. Wire shall not be less than 0.120 inch in diameter. The spelter coating, when tested in accordance with ASTM Designation: A 90, shall not be less than 0.2 ounce per square foot.

1010.08 CHAIN LINK FENCE, GATES AND APPURTENANCES.

(a) Chain link fence may be fabricated of any one of the following at the option of the contractor.

(1) Type I — Zinc-coated steel fabric, posts, hardware and fittings.

(2) Type II — Aluminum-coated steel fabric and zinc-coated steel posts, hardware and fittings.

(3) Type III — Aluminum alloy fabric, posts, hardware and fittings.

(4) Type IV — Green vinyl-clad steel fabric and zinc-coated steel posts, hardware and fittings.

(b) Height of fence, gage and mesh of fabric, gage of tension wire, type and gage of barbed wire, type and dimensions of line post, corner post, pull post, top rail, gate post, gate framing, gate opening and all other miscellaneous items required to make up the fence shall be as shown on the plans.

(c) All materials furnished, except as specified herein, shall conform to AASHTO Designation: M 181.

(1) Zinc-coated Steel Fabric: The zinc coating for steel fabric shall be a Class I coating (1.2 oz. of zinc per square foot, minimum, of uncoated wire surface) in accordance with ASTM Designation: A 392.

(2) Zinc-coated Steel Members: The zinc coating of posts, rails, expansion sleeves and gate frames shall be an average of 1.8 oz. of zinc per square foot of uncoated surface in accordance with ASTM Designation: A 120.

(3) Wire Ties and Tension Wire: All wire fabric ties, wire ties, hog rings and tension wire for use with zinc-coated steel fabric or with aluminum-coated steel fabric shall be zinc-coated steel wire or aluminum-coated steel wire, and those for use with aluminum alloy fabric shall be aluminum alloy wire.

a. Wire Ties: All wire ties, wire fabric ties and hog rings shall be of minimum size or gage designated on the plans, and shall be either ductile steel or aluminum alloy having a minimum tensile strength of 42,000 psi, a minimum yield strength of 35,000 psi, and a minimum elongation of 10 percent. Steel shall be coated with either not less than 0.7 oz. of zinc per square foot of uncoated wire surface, or with not less than 0.40 oz. of aluminum alloy per square foot of uncoated wire surface.

b. Tension Wire: All tension wires shall be minimum 9 gage wire.

1. Zinc-coated and aluminum-coated steel tension wire shall have a minimum tensile strength of 80,000 psi coated (a) with not less than 0.8 oz. of zinc per square foot of uncoated surface, or (b)

with aluminum alloy applied at the rate of not less than 0.40 oz. per square foot of uncoated wire surface.

2. Aluminum alloy tension wire shall have a minimum tensile strength of 42,000 psi, a minimum yield strength of 35,000 psi, and a minimum elongation of 10 percent. The minimum allowable gage shall be such that the aluminum alloy wire will develop a minimum ultimate tensile force equivalent to that of a 9 gage steel wire under an 80,000 psi tensile stress.

(d) Barbed wire used with chain link fence shall conform to Subsection 1010.01.

(e) Padlocks supplied by the contractor shall be solid jacket, extruded brass metal with interchangeable cores and 1¾ inch cases. All padlocks furnished shall be keyed alike. Two keys shall be furnished for each padlock.

1010.09 METAL BEAM FOR HIGHWAY GUARD RAIL. The rail elements shall be corrugated sheet steel beams conforming to plan details. The class and thickness of the metal shall be as specified on the plans. All guard rail elements, terminal sections and fittings shall be interchangeable with similar parts, regardless of source or manufacturer.

The guard rail, terminal sections and appurtenances shall be in accordance with AASHTO Designation: M 180, the plans and the following requirements.

Unless otherwise specified, the beams shall be Class B with buffer end sections being either Class A or B.

The beams shall be galvanized after fabrication with a Type 1 or 2 coating in accordance with AASHTO Designation: M 180.

The fabricator shall file a Brand Registration and Guarantee with the Department's Materials Engineer, in accordance with AASHTO Designation: M 180. Certificates of analysis shall be furnished for each heat per shipment covering all tests and measurements required by AASHTO Designation: M 180.

1010.10 GUARD RAIL POSTS AND SPACER BLOCKS. Railing posts shall be of either wood, steel or concrete as specified. When the choice of post is at the option of the contractor, there shall be only one kind furnished on the project. Spacer blocks shall be of the same material as the post.

When required depth of penetration cannot be achieved for wooden or concrete posts, steel posts may be allowed or required as shown on the plans. Spacer blocks for these steel posts shall be of the same material as the guard rail posts at the installation.

(a) Wood posts shall be treated timber of Southern Pine No. 1 S.R. or Douglas Fir Dense Construction quality and shall be of the section and

length as specified or as shown on the plans. The posts shall be fabricated or framed before treatment. Timber, preservatives and preservative treatment shall conform to Section 1014.

(b) Steel posts shall be of the section and length as specified. Steel shall conform to ASTM Designation: A 36.

The posts shall be galvanized in accordance with ASTM Designation: A 123.

(c) Precast reinforced concrete posts shall conform to the following requirements.

The acceptance of concrete shall be based upon the compressive strength of cylinders. The minimum compressive strength of cylinders shall be 3,000 psi at 28 days.

Reinforcing steel shall be deformed bars conforming to Section 1009.

Aggregate used in concrete shall conform to Section 1003 except that the gradation shall be optional with the contractor.

Forms may be removed as soon as the concrete has hardened sufficiently to prevent damage to posts. Posts shall be given a Class 1, Ordinary Surface Finish in accordance with Subsection 805.14 and shall present a neat and uniform appearance.

(d) Ground end anchorages and bridge end anchorage connections shall be as specified. Concrete and reinforcement shall conform to the requirements herein for precast reinforced concrete posts.

(e) Spacer blocks shall be of the dimensions shown on plans. Wood spacer blocks shall be of the same material and shall be treated with the same type preservatives as provided for posts. Concrete spacer blocks shall conform to the requirements herein for precast reinforced concrete posts.

1010.11 GUARD RAIL HARDWARE. Splices and end connections shall be of the type and design specified or shown on the plans and shall be of such strength as to develop the full design strength of the rail elements.

End anchor rods and accessories shall be as specified and shall be of such size and strength as to develop the full design strength of the rail elements. Bolts and nuts shall conform to ASTM Designation: A 307.

Unless otherwise specified, all fittings, bolts, washers and other accessories for steel guard rail shall be galvanized in accordance with ASTM Designation: A 123 or A 153. All galvanizing shall be done after fabrication.

1010.12 WIRE ROPE AND FITTINGS FOR HIGHWAY GUARD RAIL. Wire rope or wire cable and fittings shall conform to AASHTO Designation: M 30.

Flexible rail elements composed of multiple wires in any arrangement

other than rope form shall conform to the plan details and dimensions and to the strength requirements for the item.

1010.13 TIMBER RAIL. The timber rail shall be cut from the specified grade of dry, well seasoned and dressed timber stock conforming to Subsection 1014.01.

Where preservative treatment is specified, this shall conform to Subsection 1014.04.

Section 1011

Concrete Curing Materials, Special Finishes and Admixtures

1011.01 CURING MATERIALS. Curing materials shall conform to the following requirements.

(a) Liquid Membrane-Forming Compounds: This material shall conform to AASHTO Designation: M 148, except that specimens tested for drying time shall be maintained at a temperature of 100°F ± 2°F and a relative humidity of 32 ± 2 percent. When so tested, the membrane-forming compound shall dry to touch in not more than 2 hours.

(b) Burlap Cloth Made from Jute of Kenaf: AASHTO Designation: M 182, Class 3.

(c) Waterproof Paper: AASHTO Designation: M 171.

(d) White Polyethylene Sheeting: AASHTO Designation: M 171.

(e) Combined Burlap and White Polyethylene Sheeting: AASHTO Designation: M 171.

1011.02 ADMIXTURES. Admixtures as applied to prestressed or reinforced concrete at the approved dosage or less shall be such that the maximum contribution of chloride ion (Cl^-) due to the admixture is 0.02 pound per cubic yard of concrete. Admixtures, air-entraining and water-reducing (normal set or set retarding), shall conform to these specifications.

(a) Water-Reducing Admixtures: Water-reducing admixtures shall conform to the following requirements.

(1) The water-reducing admixture shall be a product of a company with not less than 5 years experience in the manufacture and successful field use of this type admixture. The manufacturer shall process and package the material in its own factory.

(2) All water-reducing admixtures (normal set or set retarding) submitted for preliminary approval, when tested in accordance with DOTD Designation: TR 224, shall conform to the requirements in Table IV.

(b) Air-Entraining Admixtures: All air-entraining admixtures submitted for preliminary approval, when tested in accordance with DOTD Designation: TR 224 shall conform to the requirements in Table IV.

TABLE IV
Physical Requirements For Admixtures

	Air-Entraining Admixture	Water-Reducing Admixtures	
		Normal Set	Set Retarding
Unit Water Content, Max. Percent of Control	90	95	95
Air Content, Percent, Total	5 ± 2	0 to 3	0 to 3
Time of Setting, Deviation from Control in Hours (Note 1)			
Initial Set — Max.		± 1	+ 3
Min.		-----	+ 1
Final Set — Max.		± 1	+ 3
Min.		-----	-----
Compressive Strength, Min. Percent of Control			
7 Days	85	105	105
28 Days	85	105	105

NOTE 1: The time of setting requirements in the table provide that concrete containing:
1. A water-reducing, normal set admixture must reach both initial set and final set not more than 1 hour sooner or 1 hour later than the reference concrete.
2. A water-reducing, set retarding admixture must reach initial set at least 1 hour later but not more than 3 hours later than the reference concrete and must reach final set not more than 3 hours later than the reference concrete.

(c) Qualified Products List: A list of approved water-reducing admixtures (normal set and set retarding) and air-entraining admixtures is maintained by the Department's Materials Section.

(d) Requirements for Acceptance Samples: Samples of admixtures from each lot or shipment made to a job shall be submitted to the Materials Laboratory at least 10 days prior to use of the material.

(1) Acceptance of each lot or shipment is dependent upon infrared spectrophotometric analysis and solids content tests identifying the material as being identical to the products originally approved.

(2) Tests to determine the rate of hardening and compressive strength or other properties may be made at any time during the progress of the work to insure continued compliance with the requirements of these specifications.

Samples submitted from the job shall be tested in accordance with DOTD Designation: TR 224 and shall conform to the requirements in Table IV.

1011.03 EPOXY RESIN SYSTEMS. The epoxy resin system shall be an approved product on the Qualified Products List.

1011.04 SPECIAL SURFACE FINISH.

(a) General: Special Surface Finish shall be an approved material on the Qualified Products List. The material shall provide a uniform, fine-textured finish conforming to the requirements of this specification. Method and rate of application shall be as recommended by the manufacturer, except that application rate shall not exceed 60 square feet per mixed gallon.

(b) Qualification: A manufacturer who wishes to have his product evaluated must submit a standard "Preliminary Information for Product Evaluation" form to the Department's Materials Engineer. This form, along with data sheet attachments, shall provide all pertinent information relative to the product to be evaluated; including, but not limited to, manufacturer's specifications, mixing instructions if required, recommended application procedure and rate, and typical analysis. The form shall also be accompanied by a gallon sample of the product for evaluation, along with a panel coated with the product as proposed for use, for preliminary color approval. The panel must conform to Department color requirements, as outlined below, before any further evaluation is performed.

The qualification sample will be tested in accordance with DOTD Designation: TR 620. This test method requires that the sample be applied to the test specimens and panels by the manufacturer's representative at the Department's Materials Section. The test values shall be as follows:

(1) The material shall have an average cycle of failure of not less than 50 cycles when tested in accordance with DOTD Designation: TR 231. The test specimens shall show no flaking, cracking, spalling or loss of bond.

(2) The material shall be unaffected by 500 hours exposure when tested in accordance with DOTD Designation: TR 611.

(3) The material, as applied to the test panels, shall closely match the color of the standard "Louisiana Gray" color chip on file at, and obtainable from, the Department's Materials Section.

Any product that subsequently performs unsatisfactorily in the field will be removed from the list.

(c) Project Acceptance Testing: Each lot or shipment to a project will be sampled by Department personnel prior to use in accordance with the Department's Materials Sampling Manual. Final acceptance of each lot or shipment is dependent upon satisfactory color, infrared spectrophotometric analysis, and any other tests necessary to identify the sample as being representative of the product originally approved.

Section 1012

Railings and Barriers

1012.01 GENERAL. This specification covers materials used in the construction of railings and barriers specified on the plans or in the project specifications.

1012.02 CONCRETE. Concrete for bridge railings and barriers shall conform to Section 901. Concrete for roadway barriers shall conform to Section 902.

1012.03 REINFORCING STEEL. Reinforcing steel shall consist of deformed bars conforming to Subsection 1009.01.

1012.04 STRUCTURAL STEEL. Structural steel for railings and railing posts shall consist of A 36 steel conforming to Subsection 1013.01.

1012.05 ALUMINUM PIPE RAILINGS. Aluminum pipe, castings, fittings and hardware shall be of the type, size and detail shown on the plans.

(a) Aluminum Alloy Pipe: Aluminum alloy pipe shall be standard pipe ANSI Schedule 40, and shall conform to ASTM Designation: B 241, Alloy 6061-T6 or 6063-T6.

(b) Cast Aluminum Railing Posts: Material for cast aluminum bridge railing posts shall conform to the following specifications.

(1) Scope: This specification covers permanent mold types of cast aluminum alloy roadway railing posts.

(2) Material: The chemical composition of the castings shall conform to the limits listed in the following table:

TABLE V
Composition Limits*

Cu	Fe	Si	Mn	Mg	Zn	Ti	Oth. (each)	Oth. (Total)
0.10	0.20	6.5-7.5	0.10	0.05	0.10	0.20	0.05	0.15

*All values maximum, unless shown as a range.

Minimum mechanical properties of test bars machined either vertically or horizontally from the high stressed area of the post tension flange (lower 14 inches), but not at the junction of the rib and tension flange, shall be as shown in the following table:

TABLE VI
Mechanical Properties — Castings

	Tension Flange
Ultimate Tensile Strength (psi)	20,000
Elongation (% in 2 inches or 4D) (Min.)	20

(3) Test Specimens: The tension test specimens shall be machined from integrally cast test coupons extending from one side of the base of the posts sufficiently large to permit obtaining a 0.350 inch diameter test specimen as defined in ASTM Designation: E 8.

(4) Number of Tests: A minimum of one percent of the posts in any lot, but not less than one, shall be sampled for tensile testing. A lot shall consist of not more than 1,000 pounds of clean castings when produced from a batch-type furnace charged with one heat of ingot of known analysis or not more than 2,000 pounds of clean castings when produced from one continuous furnace in not more than 8 consecutive hours.

(c) Aluminum Alloy Swedge Bolts and Nuts: Aluminum alloy swedge bolts and nuts shall be made from rods conforming to ASTM Designation: B 211, Alloy 6061-T6 or 2024-T4. Bolts shall conform to ANSI Designation: B 18.2.1, with threads conforming to the Unified Standard, Class 2 A. Nuts shall conform to ANSI Designation: B 18.2.2, with threads conforming to the Unified Standard, Class 2 B. The finished bolts and nuts shall be supplied in either the T 6 or T 4 temper and shall be given an anodic coating at least 0.0002 inch thick and dichromate sealed.

(d) Aluminum Alloy Washers: Aluminum alloy washers shall be made of sheet conforming to ASTM Designation: B 209, Alloy 2024-T4.

(e) Aluminum Alloy Shim Material: Aluminum alloy shims shall be made of sheet or plate conforming to ASTM Designation: B 209, Alloy 1100-0.

Access door cover and rail caps shall conform to either ASTM Designation: B 221, Alloy 6061-T6 or permanent mold castings ASTM Designation: B 108, Alloy A444.0-T4 conforming to the chemical and physical requirements of Tables V and VI herein.

(f) Set Screws: Machine screws for fastening access door covers to railing posts and socket head cup point set screws for fastening pipe rail to railing posts and pipe caps to railing shall be stainless steel, and they shall be furnished by the supplier.

1012.06 GALVANIZED STEEL PIPE RAILINGS. The standard weight galvanized steel pipe, castings, fittings and hardware shall be of the type, size and detail shown on the plans. Galvanized surfaces to be placed in contact with concrete shall be given a heavy coat of an approved alkali-resistant bituminous paint and allowed to dry before placing on the concrete. However, a pad of clear, opaque polyethylene film of not less than 6 mils thickness may be placed between the galvanized and concrete surfaces in lieu of the paint and trimmed to the perimeter of the casting base after casting has been bolted down.

The galvanized steel pipe shall be of standard weight conforming to ASTM Designation: A 53. From each 1,000 feet or less of galvanized pipe, a sample not less than one foot in length shall be submitted to the Materials Section for examination and approval as to wall thickness and zinc spelter thickness before shipment.

Fittings and castings for steel pipe shall be of malleable iron or cast steel and shall conform to ASTM Designation: A 47, Grade 35018 or ASTM Designation: A 27, Grade 70-36. All fittings and castings shall be galvanized, in accordance with ASTM Designation: A 153. Repairs to galvanized surfaces shall be made in accordance with Subsection 811.16.

Three copies of certificates of analysis giving chemical and physical test results shall be forwarded for approval to the Construction Section for each heat or foundry pour of iron or steel post castings with certificates of compliance as to the ounces per square foot of the zinc spelter coating applied to these castings.

All bolts, nuts, washers and screws shall be of the type, size and detail shown on the plans.

All bolts, nuts and washers (except high strength bolts) shall conform to ASTM Designation: A 307, Grade A.

When high tensile bolts are required, such bolts shall conform to ASTM Designation: A 325. All bolts, nuts and washers shall be galvanized in accordance with ASTM Designation: A 153.

Machine screws for fastening access door covers to railing posts and socket head cup point set screws for fastening pipe rail to railing posts and pipe caps to railing shall be stainless steel and shall be furnished by the supplier.

Section 1013

Metals

1013.01 STRUCTURAL STEEL. Unless otherwise specified, the contractor will be required to obtain all applicable physical and chemical tests and furnish the Department's Construction Section with three copies of the certificates of analysis.

The type of structural steel to be used shall be as specified and shall conform to the following ASTM specifications as amended by the requirements of this Subsection.

ASTM Designation	Description
A 36	Structural Carbon Steel.
A 242	High-Strength, Low-Alloy Structural Steel.
A 440	High-Strength, Structural Steel.
A 441	High-Strength, Low-Alloy Structural Manganese Vanadium Steel.
A 514	High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
A 572	High-Strength, Low-Alloy Columbium Vanadium Steel.
A 588	High-Strength, Low-Alloy Structural Steel (50,000 psi Minimum Yield Point to 4 inch thick).

Longitudinal Charpy V-notch Testing of Structural Steel: When designated on the plans, the main load carrying structural member components that are subject to tensile stress shall meet the longitudinal Charpy V-notch test specified in Tables VII, VIII and IX. Sampling and testing procedures shall be in accordance with ASTM Designation: A 673 and the following requirements: the (H) frequency of heat testing shall be used for all steels except that for A 514 the (P) frequency of piece testing shall be used.

1013.02 BOLT AND RIVET STEEL.

(a) Bolts, Nuts and Circular Washers shall conform to ASTM Designations: A 325 or A 490, whichever is specified. For A 325 Bolts, Type 1

TABLE VII
Types A 36, A 242, A 440 and A 441 Structural Steel

Thickness	Specified Minimum Average Energy Absorbed (Ft. Lbs. @ 70°F)
Up to 4″	15

TABLE VIII
Types A 572 and A 588 Structural Steel*

Thickness	Specified Minimum Average Energy Absorbed (Ft. Lbs. @ 70°F)
Up to 4″ mechanically fastened	15
Up to 2″ welded	15
Over 2″ to 4″ welded (A 588 Steel only)	20

* If the yield point of the material exceeds 65 ksi, the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10 ksi above 65 ksi.

TABLE IX
Type A 514 Structural Steel

Thickness	Specified Minimum Average Energy Absorbed (Ft. Lbs. @ 30°F)
Up to 4″ mechanically fastened	25
Up to 2½″ welded	25
Over 2½″ welded	35

shall be used; except when unpainted A 588 structural steel is specified, Type 3 bolts shall be required.

(b) Structural Rivet Steel shall conform to ASTM Designation: A 502, Grade 1.

(c) High Strength Rivet Steel shall conform to ASTM Designation: A 502, Grade 2.

1013.03 COPPER BEARING STEEL. When copper bearing steel is specified, the steel shall contain not less than 0.2 percent copper.

1013.04 STEEL FORGINGS AND STEEL SHAFTING.

(a) Carbon and Alloy Steel Forgings: Steel forgings shall conform to ASTM Designation: A 668. Class C forgings shall be furnished except in cases specified below or otherwise specified.

(1) Forged shafts shall conform to ASTM Designation: A 668, Class F.

(2) Forged trunnions shall conform to ASTM Designation: A 668, Class G.

(b) Alloy Steel Forgings for Pinions and Reduction Gears: Alloy steel forgings for pinions and reduction gears shall conform to ASTM Designation: A 291, Class 3 or 3A.

(c) Cold Finished Carbon Steel Shafting: Cold finished carbon steel shafting shall conform to ASTM Designation: A 108. Grade Designation 1016-1030 inclusive, shall be furnished, unless otherwise specified.

1013.05 STEEL CASTINGS.

(a) Steel Castings for Highway Bridges: Steel castings for use in highway bridge components shall conform to ASTM Designation: A 486 or A 27. Class 70 or Grade 70-36 respectively, shall be used, unless otherwise specified.

(b) High Strength Steel Castings: High strength carbon and alloy steel castings shall conform to ASTM Designation: A 148, Grade to be as specified.

(c) Chromium Alloy Steel Castings: Chromium alloy steel castings shall conform to ASTM Designation: A 296, Grade CA-15.

1013.06 CASTINGS. All castings shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. The castings shall be boldly filleted at angles and the arises shall be sharp and perfect. Malleable casting surfaces shall have a workmanlike finish.

All castings shall be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

(a) Gray Iron Castings: Gray iron castings shall conform to ASTM Designation: A 48, Class 30.

(b) Malleable Castings: Malleable castings shall conform to ASTM Designation: A 47, Grade 35018.

(c) Ductile Iron Castings: Ductile iron castings shall conform to ASTM Designation: A 536, Grade 60-40-18. For ductile iron castings weighing more than 1,000 pounds, the finished casting shall be ultrasonically tested to check for holes and voids in order to determine that the

required quality is obtained in the finished condition.

1013.07 BRONZE OR COPPER ALLOY BEARING AND EXPANSION PLATES.

(a) Bronze Bearing and Expansion Plates: Bronze bearing and expansion plates shall conform to ASTM Designation: B 22, Alloy 911.

(b) Rolled Copper-Alloy Bearing and Expansion Plates: Rolled copper-alloy bearing and expansion plates shall conform to ASTM Designation: B 100, Alloy 510.

1013.08 BOLTS, NUTS AND WASHERS. Bolts and nuts from different manufacturers shall not be mixed.

(a) All bolts and nuts, except high strength bolts, unless otherwise specified, shall conform to ASTM Designation: A 307, Grade A.

(b) High strength bolts, nuts and washers shall conform to Subsection 1013.02(a).

(c) Subject to the approval of the engineer, high strength steel lock-pin and collar fasteners including washers, may be used as an alternate for high strength bolts or rivets. The shank and head of the high strength steel lock-pin and collar fasteners shall meet the chemical composition and mechanical property requirements of ASTM A 325 or ASTM A 490, whichever is specified. Each fastener shall provide a solid shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than the bolt or rivet specified and shall have a cold forged head on one end of type and dimensions approved by the engineer, a shank length suitable for material thickness fastened and locking grooves, breakneck groove and pull grooves (all annular grooves) on the opposite end. Each fastener shall provide a steel locking collar of proper size for shank diameter used, which, by means of suitable installation tools, is cold swaged into the locking grooves forming a head for the grooved end of the fastener after the pull groove section has been removed. The steel locking collar shall be a standard product of an established manufacturer of lock-pin and collar fasteners, as approved by the engineer.

1013.09 STEEL BEARING PILES. Steel bearing piles shall conform to ASTM Designation: A 36.

1013.10 STEEL SHEET PILES. Steel sheet piling shall be of the type and weight specified and shall conform to ASTM Designation: A 328.

1013.11 STEEL PIPE PILES. Steel for pipe piles shall conform to ASTM Designation: A 252, Grade 2.

1013.12 CORRUGATED METAL UNITS. Corrugated metal units shall conform to plan dimensions and the metal to AASHTO Designation: M 36. Bituminous coating, when specified, shall conform to AASHTO Designation: M 190, Type A.

1013.13 SHEET COPPER. Sheet copper shall conform to ASTM Designation: B 152.

1013.14 SHEET LEAD. Sheet lead shall conform to ASTM Designation: B 29.

1013.15 SHEET ZINC. Sheet zinc shall conform to ASTM Designation: B 69, Type II.

1013.16 COLD ROLLED STEEL. Cold rolled steel shall conform to ASTM Designation: A 108.

1013.17 BRONZE.

(a) Bronze for center discs for movable bridges shall conform to ASTM Designation: B 22, Alloy 913.

(b) Bronze for trunnion and similar bearings for movable bridges shall conform to ASTM Designation: B 22, Alloy 911.

(c) Bronze for shafts and ordinary bearings shall conform to ASTM Designation: B 22, Alloy 937.

(d) Bronze for gears, nuts transmitting motion and other parts involving stresses other than compression shall conform to ASTM Designation: B 22, Alloy 905.

1013.18 BABBITT METAL. Babbitt metal shall conform to ASTM Designation: B 23, Alloy Number 3.

1013.19 STEEL FOR CENTER DISCS (Movable Bridges). Steel for center discs shall conform to ASTM Designation: A 668, Class F.

1013.20 STEEL FOR KEYS (Movable Bridges). Steel for keys shall conform to ASTM Designation: A 668, Class D.

1013.21 SEAMLESS STEEL PIPE AND TUBING FOR HYDRAULIC LINES. Carbon steel pipe for hydraulic lines shall conform to ASTM Designation: A 106, Grade B. Fittings for hydraulic lines shall conform to ASTM Designation: A 105.

Stainless steel tubing shall be seamless austenitic stainless steel and shall conform to ASTM Designation: A 269, type to be as specified.

1013.22 STEEL FOR OPEN GRID BRIDGE FLOORING. All steel shall conform to Subsection 1013.01.

The contractor or his fabricator shall furnish certificates of analysis of all applicable ASTM tests and submit 3 copies to the Department's Construction Section.

1013.23 DUCTILE CAST IRON BEARINGS. Nodular cast iron bearings shall conform to ASTM Designation: A 536. The grade shall be as specified.

1013.24 SHEAR CONNECTORS.

(a) General:

(1) Shear connector studs shall be of a design suitable for endwelding to steel beams and girders with automatically timed stud welding equipment. The type, size or diameter and length of stud shall be as specified. (See Figure 1 for allowable tolerances on dimensions.)

(2) An arc shield (ferrule) of heat-resistant ceramic or other suitable material shall be furnished with each stud. The material shall not be detrimental to the welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed. Ferrules furnished with shop welded studs shall be removed in the shop prior to delivery, and ferrules furnished with field welded studs shall be removed before placing concrete.

(3) Flux for welding shall be furnished with each stud, either attached to the end of the stud or combined with the arc shield for automatic application in the welding operation.

(4) Only qualified studs shall be used. A stud, to be qualified, shall have passed the tests prescribed in DOTD Designation: TR 601. The arc shield used in production shall be the same as used in the qualification tests.

(5) Before placing orders for studs, the contractor shall submit to the engineer for approval the following information on the studs to be purchased:

a. The name of the manufacturer.

b. A detailed description of the stud and arc shield to be furnished.

c. A certification from the manufacturer that the stud is qualified as specified in Heading (a)(4) of this Subsection.

d. A copy of the qualification test report as certified by the testing laboratory.

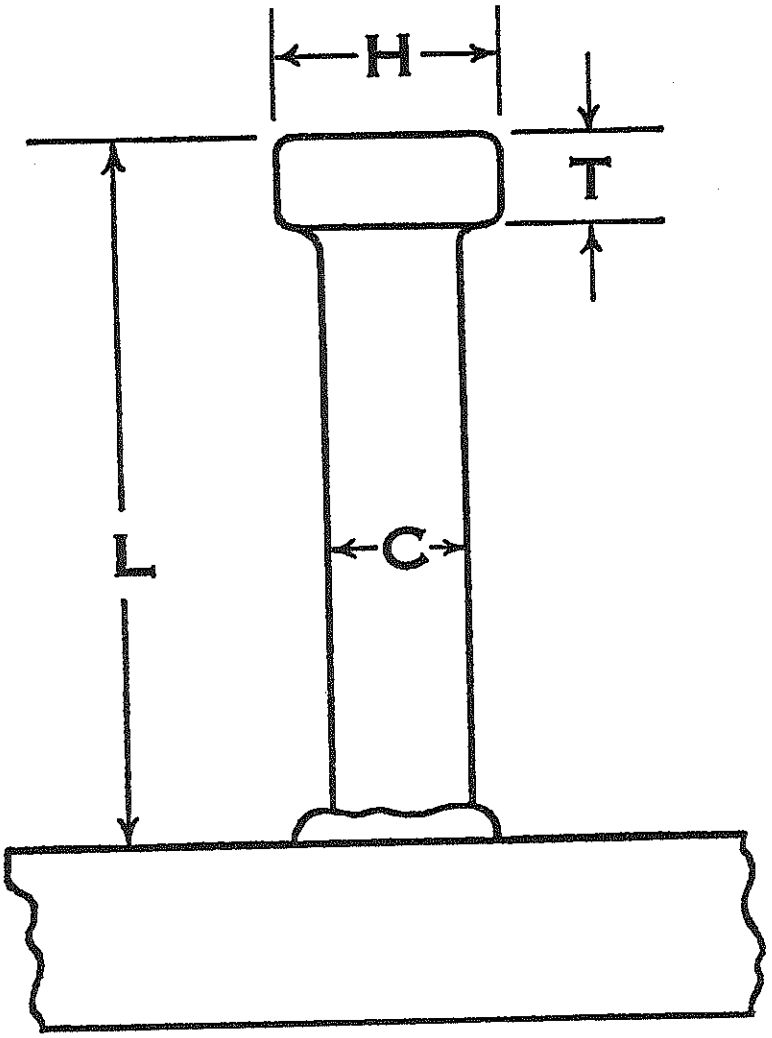
e. A notarized copy of mill test reports showing conformance to the material requirements of Headings (b)(1) and (b)(2).

(6) The studs, after welding, shall be free from any defect or substance which would interfere with their function as shear connectors.

(b) Material Requirements:

(1) Shear connector studs shall conform to ASTM Designation: A 108, cold-drawn bar, Grades 1010 to 1020 inclusive, either semi- or fully-killed. If flux-retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall conform to ASTM Designation: A 109.

Figure 1
DIMENSIONS AND TOLERANCES



Standard Dimensions — Inches

C	L*	H	T
3/4 − .015	4 $^{+\ .062}_{-\ .125}$	1-1/4 ± 1/64	3/8 Min.
7/8 − .015	4 $^{+\ .062}_{-\ .125}$	1-3/8 ± 1/64	3/8 Min.

*4 inches length is standard. Other lengths may be obtained by special order.

(2) Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile Strength (Min.)	60,000 psi
Yield Strength* (Min.)	50,000 psi
Elongation (Min.)	20% in 2 in.
Reduction of area (Min.)	50%

*As determined by a 0.2 percent offset method.

(3) Tensile properties shall be determined in accordance with ASTM Designation: A 370. Tensile tests of finished studs shall be made on studs welded to test plates using a test fixture similar to that given in DOTD Designation: TR 601. If fracture occurs outside of the middle half of the gage length, the test shall be repeated.

(4) Finished studs shall be of uniform quality and condition and free from injurious laps, fins, seams, cracks, twists, bends or other injurious defects. Finish shall be as produced by cold drawing, cold rolling or machining.

(5) The manufacturer shall certify that the studs are in accordance with the material requirements of this Section. Certified copies of in-plant quality control test reports shall be furnished to the engineer upon request.

(6) The engineer may select, at the contractor's expense, studs of each type and size used under the contract, as necessary for checking conformance with the requirements of these specifications.

1013.25 CONCRETE ANCHOR STUDS. Concrete anchor studs used for end dam plates, bearing plates, or as any other concrete anchorage, shall conform to Subsection 1013.24, except as modified by the Department's Welding Procedures Manual.

1013.26 WIDE FLANGE BEAM. Wide flange beams for approach slabs shall conform to ASTM Designation: A 242.

Reinforcing straps shall conform to ASTM Designation: A 36.

Section 1014

Timber and Timber Preservatives

1014.01 STRUCTURAL TIMBER AND LUMBER. The species, grade and treating of structural timber and lumber shall be as specified and shall conform to AASHTO Designation: M 168 and the following requirements.

(a) Southern Pine Timber: Referring to the latest Standard Grading Rules for Southern Pine Lumber, as published by the Southern Pine Inspection Bureau, Southern Pine lumber shall be furnished in grades with definite unit working stresses assigned as indicated for grade of lumber required.

(1) For caps, stringers, decking and bridge rails, the material shall conform to the following:

Grade: No. 1 Dense SR Timbers

(2) For items other than caps, stringers, decking and bridge rail, the material shall conform to the following:

Grade: No. 1 SR Timbers

(b) Douglas Fir Timber: Referring to the latest Standard Grading Rules for Western Lumber, Douglas Fir lumber shall be furnished in accordance with the following:

(1) Caps, stringers, decking and bridge rail shall conform to Section 70.10 "Select Structural." Unless otherwise specified, design values shall be in accordance with Table 4, page 176, "Recommended Design Values in Pounds Per Square Inch."

(2) Items other than caps, stringers, decking and bridge rail shall conform to Section 70.11, Grade 1. Unless otherwise specified, design values shall be in accordance with Table 4, page 176, "Recommended Design Values in Pounds Per Square Inch."

1014.02 TIMBER PILING. Timber piles shall be Southern Yellow Pine or Douglas Fir and shall conform to ASTM Designation: D 25; except that Table X herein shall be used in lieu of Tables I and II in ASTM Designation: D 25.

Table X
CIRCUMFERENCES AND DIAMETERS OF TIMBER PILES

Length, Feet	3 Feet from Butt				At Tip, Min.	
	Min.		Max.			
	Circumference, Inches	Diameter (Approx.) Inches	Circumference, Inches	Diameter (Approx.) Inches	Circumference, Inches	Diameter (Approx.) Inches
DOUGLAS FIR OR PINE						
Under 40	38*	12*	63	20	25	8
40 to 54 Incl.	38	12	63	20	22	7
55 to 74 Incl.	41	13	63	20	22	7
75 to 90 Incl.	41	13	63	20	19	6
Over 90	41	13	63	20	16	5

*A minimum circumference of 34 inches or diameter of 11 inches at a point 3 feet from the butt may be specified for lengths of 25 feet and under.

NOTE: All of the above measurements shall be taken under the bark. The diameter at 3 feet from the butt shall not exceed 20 inches.

1014.03 TIMBER PRESERVATIVES. The type preservatives to be used are as follows:

Creosote Oil — AWPA P1 for regular treatment; AWPA P 13 for marine treatment.

Creosote Coal-Tar Solution — AWPA P 2, Grade A, for regular treatment; AWPA P12 for marine treatment. The ratio shall be 80 percent creosote oil and 20 percent coal-tar.

Pentachlorophenol-Petroleum Solution — AWPA P8 and P9.

Chromated Copper Arsenate — Type B, AWPA P5.

1014.04 TREATMENT.

(a) General: All materials shall be treated according to current AWPA Standard Specifications for Preservative Treatment by Pressure Processes, modified as follows:

Timber and Lumber ..... C1 and C2
Piles ..... C1 and C3

Poles	C1 and C4
Posts, Round	C1 and C5
Posts, Square Sawn	C1 and C2
Lumber, Fire Retardant	C1 and C20

Air-dried timber shall be steamed prior to treatment for a minimum of 6 hours.

Kiln-dried timber shall be steamed prior to treatment for a minimum of 2 hours.

(b) Amount of Preservative: For acceptance purposes, the net retention in any charge by gage shall not be less than 100 percent of the specified quantity of preservative; and for verification, the net retention in any charge by random assay shall not be less than 85 percent of the quantity specified. If it is found necessary for the Department to use assay as the sole acceptance criteria, then the retention shall be at least 90 percent of the specified quantity of preservative. The minimum amount of preservative retained shall be as follows:

(1) Creosote, Creosote Coal-Tar Solution or Pentachorophenol-Petroleum Solution Treatment shall be as follows:

Material	**Min. Net Retention of Preservative Per Cu. Ft. of Wood (Lbs.)**
Southern Pine Timber	16
Douglas Fir Timber	16
Douglas Fir Piles	17
Southern Yellow Pine Piles	16
Southern Yellow Pine Class Poles	10
Southern Yellow Pine Foundation Piles	12
Douglas Fir Foundation Piles	17
Southern Yellow Pine Piles and Timber for Use in Coastal Water (to be specified in plans or project specifications	20
Douglas Fir Piles and Timber for Use in Coastal Water (to be specified in plans or project specifications)	20
Fence and Gate Posts	8
Guard Rail Posts and Spacer Blocks	10
Bridge Rail	12

(2) Timber and lumber used in the construction of bridges shall be treated with either creosote oil or creosote coal-tar solution.

(3) Timber piles shall be treated with creosote coal-tar solution.

(4) Timber guard rail posts including spacer blocks treated with creosote oil shall be steam flushed after treatment.

(5) Bridge rail shall be treated with pentachlorophenol-petroleum solution.

(6) Fence and gate posts may be treated with 0.4 lb./cu. ft. chromated copper arsenate (CCA) Type B conforming to AWPA P5.

(c) Painting: When painting of treated material is required, one of the following preservatives shall be used:

Ammonical Copper Arsenate (ACA) — conforming to AWPA P5.

Chromated Copper Arsenate (CCA) Type A, B or C — conforming to AWPA P5.

Pentachlorophenol — conforming to AWPA P8.

Hydrocarbon solvents for oil borne preservatives shall conform to AWPA P9, Type B (Volatile Petroleum Solvent, LPG) or Type D (Chlorinated Hydrocarbon Solvent-Inhibited Grade of Methylene Chloride).

(1) The minimum retention shall be as follows:

Ammonical Copper Arsenate	0.4 lb./cu. ft.
Chromated Copper Arsenate Types A, B or C	0.4 lb./cu. ft.
Pentachlorophenol	0.4 lb./cu. ft.

(2) Any timber showing discoloration or bleeding due to treatment shall be repainted by the contractor at no cost to the Department.

1014.05 TIMBER CONNECTORS, HARDWARE AND STRUCTURAL SHAPES. Timber connectors, hardware and structural shapes shall conform to Subsections 1017.07 and 1017.08.

1014.06 INSPECTION. All inspection shall be in accordance with AWPA Standard M2 and quality control shall be in accordance with AWPA Standard M3.

Section 1015

Signs and Pavement Markings

1015.01 DESCRIPTION. This section covers material requirements for temporary construction signs, traffic signs, route markers, delineators, pavement markings and related material items.

1015.02 GENERAL REQUIREMENTS. The materials shall conform to these specifications, the plans and the Louisiana Manual on Uniform Traffic Control Devices (MUTCD).

Sampling frequency shall be in accordance with the Department's Materials Sampling Manual and when directed it shall be the responsibility of the contractor to furnish and prepare all samples for testing in accordance with Department instructions.

All signs shall be subject to inspection after they have been erected and are in their final position. The engineer may elect to inspect signs at the site of manufacture or any other point between manufacture and final erection; however, final acceptance of signs and markings will be made after erection.

1015.03 METALS.

(a) Ferrous Metals:

(1) Structural Steel: Structural steel for built-up sign panels, posts, stringers, framing and miscellaneous steel shall be of standard shapes conforming to ASTM Designation: A 36. Protective coatings shall be in accordance with Subsection 729.03(c).

(2) Steel Pipe: Steel pipe or tubing for structures shall be Schedule 40 (STD) conforming to ASTM Designation: A 53, Type E or S, Grade B or hot formed tubing conforming to ASTM Designations: A 36 and A 501.

(3) Steel Panels: Sheet steel blanks shall be continuous coat galvanized and conform to ASTM Designation: A 525, coating G 90, and mill phosphatized to a thickness of 100 $\pm$ 50 milligrams per square foot of surface area.

(4) Steel Posts for Small Signs, Markers and Delineators: Posts shall be steel of the flanged channel type shown on plans, galvanized after fabrication in accordance with Subsection 811.16. The galvanized posts shall be of the weight specified with a $\pm$ 3.5 percent tolerance.

The tensile strength of steel shall be determined from a sample, cut from one of the posts, measuring 0.5 inch in width and 10 inches in length and shall be 60,000 psi (minimum). Holes measuring ⅜ inch in diameter shall be drilled or punched through the middle of each post on 1-inch centers for a distance of at least 36 inches from the top of each post.

(b) Aluminum Alloy:

(1) Structural Members and Miscellaneous Aluminum: The structural members shall be aluminum alloy ASTM Designation: B 221 or B 429, 6061-T6. Miscellaneous aluminum shall conform to ASTM Designation: B 209, Alloy 6061-T6.

(2) Aluminum Panels: All sheets and plates shall conform to ASTM Designation: B 209, Alloy 6061-T6.

(c) Fittings:

(1) Structural Bolts, Nuts and Washers: All high strength bolts shall be ASTM Designation: A 325 and all other bolts ASTM Designation: A 307, Grade A. Bolts shall have hexagonal heads and supplied with 2 flat and one lock washer and hexagonal head nut. Bevel washers where required shall be wrought steel. Bolts, nuts and washers shall be galvanized in accordance with ASTM Designation: A 153 or electroplated in accordance with ASTM Designation: A 164 with a type GS zinc coating.

Anchor bolts shall be ASTM Designation: A 36 galvanized in accordance with Subsection 811.16.

Stainless steel bolts shall conform to ASTM Designation: A 320, Grade B8, annealed or approved equal.

(2) Fasteners: Fasteners for use in fabricating sign faces, including splice plates for joining 2 panels, sills, and border angles shall have brasier heads and shall be manufactured from aluminum alloy 2024-T4 or approved equal. Collars shall be of the type and alloy recommended by the manufacturer.

Fasteners for delineator, hazard marker and milepost assemblies shall be vandal resistant of the type shown on the plans and be approved by the Department prior to use.

1015.04 SIGN PANELS FOR TEMPORARY CONSTRUCTION SIGNS. This subsection shall apply to temporary construction sign panels only. These panels may be made from sheet aluminum, sheet steel or wood.

(a) Aluminum: Aluminum sheeting shall be 0.080 inch thickness conforming to ASTM Designation: B 209, Alloy 6061-T6 or other approved aluminum sheeting.

(b) Steel: Steel sheeting shall be 0.060 inch minimum thickness em-

bossed or 0.075 inch minimum thickness prior to coating and shall conform to ASTM Designation: A 569 or other approved sheet steel. The steel sheeting shall be properly cleaned and prepared for applying protective coating and then receive an approved two-application protective coating.

(c) Wood: Plywood sheeting of exterior type Grades (1) High Density Overlay, (2) Medium Density Overlay and (3) Special Exterior Grades A-A and A-B are acceptable for use provided the following requirements are met.

(1) General: Each panel shall conform to the latest "American Plywood Association" Specification and be identified with the DFPA edge mark or back stamp to verify inspection and testing. Prior to application of the reflective sheeting the entire application surface shall be abraded with steel wool or light to fine sand paper, and wiped thoroughly clean with naphtha or other acceptable commercial solvents. Allow surface a minimum of 8 hours to dry prior to application of sheeting. All cut edges of plywood panels shall be sealed with an approved sealer.

(2) Medium Density Overlay: All surfaces and edges shall be painted with an approved exterior enamel.

(3) Special Exterior Grades A-A and A-B: All surfaces and edges shall be adequately sealed with an approved sealer.

1015.05 REFLECTIVE SHEETING.

(a) Description: The reflective sheeting shall be Type I Enclosed Lens or Type II Encapsulated Lens as specified. The reflective sheeting shall have been previously tested, approved and listed on the Department's Qualified Products List.

(1) The Type I enclosed lens sheeting shall consist of spherical lens elements embedded within a flexible transparent weatherproof film having a smooth, flat outer surface.

(2) The Type II encapsulated lens sheeting shall consist of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface.

(b) Adhesive: The reflective sheeting shall include a precoated pressure sensitive adhesive backing (Class 1) or a tack-free heat activated adhesive backing (Class 2) either of which may be applied without necessity of additional adhesive coats on either the reflective sheeting or application surface.

The Class 1 adhesive backing shall be a pressure sensitive adhesive of the aggressive tack type requiring no heat solvent or other preparation for adhesion to smooth clean surfaces. The Class 2 adhesive backing shall be a tack-free adhesive activated by applying heat in excess of 175°F to the material as in the heat-vacuum process of sign fabrication.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents without breaking, tearing or removing any adhesive from the backing. The protective liner shall be easily removed following accelerated storage for 4 hours at 160°F under a weight of 2.5 psi.

The adhesive shall form a durable bond to smooth corrosion and weather resistant surfaces and shall be tough enough to resist scuffing and marring during handling and elastic enough to resist shocking off when struck at low temperatures or sliding off at high temperatures. The adhesive shall be strong enough to resist peeling the reflective sheeting from the application surface when a 5 pounds per inch width force is applied as outlined in DOTD Designation: TR 624, Method A, or to support a 1¾ pound weight for 5 minutes, without the band peeling for a distance of more than 2.0 inches when tested as outlined in DOTD Designation: TR 624, Method B.

The adhesive shall be sufficiently moisture-resistant to withstand a cycle of 8 hours of water soaking followed by an overnight drying without appreciable decrease in adhesion.

(c) Photometric Requirements:

(1) The reflective sheeting shall have the minimum brightness values shown in Tables XI and XII at .2° and .5° divergence expressed as average candlepower per footcandle per square foot of material. Measurements shall be conducted in accordance with standard testing procedures for reflex reflectors in accordance with DOTD Designation: TR 625.

Table XI

TYPE I — ENCLOSED LENS REFLECTIVE SHEETING

	Silver-White		Yellow		Red		Blue		Green		Orange		Brown	
Div. Angle	.2	.5	.2	.5	.2	.5	.2	.5	.2	.5	.2	.5	.2	.5
Inc. Angle														
− 4	70	30	50	25	14.5	7.5	4.0	2.0	9.0	4.5	25	13.5	1.0	0.35
+30	30	15	22	13	6	3	1.7	0.8	3.5	2.2	7.0	4.0	0.3	0.2

Table XII

TYPE II — ENCAPSULATED LENS REFLECTIVE SHEETING

	Silver		Green		Yellow		Red		Orange		Blue	
Div. Angle	.2	.5	.2	.5	2	.5	.2	.5	.2	.5	.2	.5
Inc. Angle												
− 4	180	65	30	12	95	40	35	13	70	25	20	7.5
+30	100	36	17	6	49	23	19	7.8	40	15	11	4.4

(2) **Applied or Demountable Copy:** Reflective sheeting for all sign copy including letters, numerals, symbols, borders and route markers shall be sheeting which has been carefully selected by the manufacturer for uniformity of day and night appearance. Reflective sheeting for legend shall be Type I Silver-White or Type II Silver. No further matching shall be necessary.

(3) **Rainfall Performance:** The brightness of the reflective sheetings totally wet by rain shall not be less than 90 percent of the values shown in Tables XI and XII. Wet performance measurements shall be conducted in accordance with DOTD Designation: TR 625.

(d) Color: The colors for each type of sheeting shall be matched visually and be within the limits shown in Table XIII as determined in accordance with DOTD Designation: TR 626. The standards to be used for reference shall be the Munsell Papers designated in this table.

Table XIII
COLOR SPECIFICATIONS LIMITS AND REFERENCE STANDARDS

	Chromaticity Coordinates (Corner Points)								Reflectance Limit Y		Ref. Std. MUNSELL PAPERS
	1		2		3		4				
	x	y	x	y	x	y	x	y	Min.	Max.	
Silver-White	.303	.287	.368	.353	.340	.380	.274	.316	30.0	- - -	5PB 7/1
Green	.030	.380	.166	.346	.286	.428	.201	.776	3.0	8.0	10G 3/8
Yellow	.498	.412	.557	.442	.479	.520	.438	.472	16.0	40.0	1.25Y 6/12
Red	.613	.297	.708	.292	.636	.364	.558	.352	4.0	11.0	7.5R 3/12
Orange	.550	.360	.630	.370	.581	.418	.516	.394	17.0	30.0	2.5YR 5.5/14
Blue	.144	.030	.244	.202	.190	.247	.066	.208	1.0	10.0	5.8PB 1.32/6.8
Brown	.445	.353	.604	.396	.556	.443	.445	.386	3.8	7.7	5YR 3/6

(e) Film:

(1) Flexibility: Type I Enclosed Lens Material: The sheeting, applied according to the manufacturer's recommendations to a clean, etched 0.020″ x 2″ x 8″ aluminum panel of alloy 6061-T6 conditioned a minimum of 48 hours and tested at 72°F ± 2°F and 50 ± 4 percent relative humidity shall be sufficiently flexible to show no cracking when bent around a ¾ inch mandrel.

Type II Encapsulated Lens Material: The sheeting, with the liner removed and conditioned for 24 hours at 72°F ± 2°F and 50 ± 4 percent relative humidity, shall be sufficiently flexible to show no cracking when slowly bent, in one second's time, around a ⅛ inch mandrel with adhesive contacting the mandrel.

(2) **Surface:** The sheeting surface shall be smooth and flat, facilitate cleaning and wet performance, and exhibit 85° gloss meter rating of not less than 50 when tested in accordance with ASTM Designation: D 523. The sheeting surface shall be compatible with recommended transparent and opaque process colors and show no appreciable physical or handling changes with normal processing, cutting and application and shall permit cutting and color processing at temperatures 60-100°F and relative humidity of 20-80 percent.

(3) **Cleanability:** The sheeting surface shall be solvent resistant such that it may be cleaned with VM&P Naptha, mineral spirits, turpentine, or water with no appreciable loss of reflective intensity or change in appearance.

(f) Impact Resistance: The sheeting, applied according to manufacturer's recommendations to cleaned and etched 0.040″ x 3″ x 5″ aluminum and conditioned for a minimum of 24 hours at room temperature, shall show no cracking when face of panel is subjected to impact of a 2-pound weight with ⅝ inch rounded tip at a 10 inch-pound setting on a Gardner Variable Impact Tester.

(g) Shrinkage: A 9″ x 9″ reflective sheeting specimen with liner shall be conditioned a minimum of 1 hour at 72°F ± 2°F and 50 ± 4 percent relative humidity. The liner shall be removed and the specimen placed on a flat surface with the adhesive side up. Ten minutes after liner is removed and again after 24 hours, the specimen shall be measured to determine the amount of dimensional change. The reflective sheeting shall not shrink in any dimension more than 1/32 inch in 10 minutes nor more than ⅛ inch in 24 hours.

(h) Durability: The reflective sheeting, when processed, applied and cleaned in accordance with recommended procedures, shall perform satisfactorily for a minimum period of at least 7 years (3 years in the case of orange) outdoors and shall retain a minimum brightness as specified in Table XIV. The contractor shall supply the Department with a statement of performance life for the minimum retained brightness required.

The reflective material exposed at an approved test facility for 24 months in Florida or Louisiana at 45 degrees south facing shall not support fungus growth and accumulate dirt to the extent that the reflective brightness before cleaning is less than 75 percent of the reflective brightness after cleaning, when measured at 0.2 degree divergence and − 4 degrees incidence. The precoated adhesive shall have no staining effect on the reflective sheeting.

The Type I sheeting surface must be readily refurbishable by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

TABLE XIV

Sheeting Type and Color	Average Min. Candlepower Per Footcandle Per Sq. Ft. at 0.2° Divergence and − 4° Incidence
Type I (Enclosed Lens)	
Silver-White	30
Yellow	20
Red	5
Blue	2
Green	3
Orange	10
Brown	0.4
Type II (Encapsulated Lens)	
Silver	120
Red	28
Blue	16
Green	20
Yellow	60
Orange	56

(i) **Accelerated Weathering:** Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values listed in Table XI for Type I enclosed lens sheeting and not less than 70 percent of the values listed in Table XII for Type II encapsulated lens sheeting when subjected to accelerated weathering for 1,000 hours or 2,200 hours, respectively, in accordance with DOTD Designation: TR 611.

1015.06 NONREFLECTIVE SHEETING.

(a) General Requirements: The nonreflective sheeting film shall consist of an extensible, pigmented, weather-resistant plastic film. The face side of film shall be supported and protected by a paper liner which is readily removable after application without the necessity of soaking in water or other solvents. The colors shall be matched visually and be within the limits shown in Table XIII as determined in accordance with DOTD Designation: TR 626.

(b) Adhesive Requirements: The sheeting shall be a precoated pressure sensitive adhesive backing or a tack-free heat activated adhesive backing either of which may be applied without additional coats on either sheeting or application surface. The adhesive shall conform to Subsection 1015.05(b).

(c) Physical Characteristics: The film shall be readily cut by normal

fabricating methods without cracking, checking or flaking. The applied film shall be free from ragged edges, cracks and blisters, and the material shall have demonstrated its ability to withstand normal weathering without checking, cracking or excessive color loss. The sheeting surface shall be solvent resistant such that it may be cleaned with VM&P Naptha, mineral spirits, turpentine, or water with no appreciable change in appearance.

1015.07 SIGN ENAMELS AND PAINTS.

(a) Sign Enamels or Paints: These shall be applied in accordance with the manufacturer's recommendations, and the final appearance as well as materials used shall meet with the approval of the engineer.

(b) Silk Screen Paste: Constituents used in manufacture of silk screen paste shall meet the approval of the engineer. Silk screen paste shall be mixed at the factory, well ground to a uniform consistency and smooth texture, and shall be free from water and other foreign matter. It shall dry within 18 hours to a good film without running, streaking, or sagging. Any paste which has livered, hardened or thickened in the container, or in which the pigment has settled out so that it cannot be readily broken up with a paddle to a uniform usable consistency, will be rejected. The paste and thinner shall be used in accordance with the manufacturer's recommendations.

The paste shall have proper pigmentation and consistency for use on silk screen equipment. The material shall produce the desired color and the same brightness values as required for reflective sheeting of the same type and color when applied on reflective sheeting background. The paste shall meet the quality and test requirements for appearance, coarse particles, and moisture and water resistance as specified for sign paints.

1015.08 PAVEMENT MARKINGS. The marking material shall be a pressure-sensitive pavement striping tape. The marking material shall have a precoated pressure-sensitive adhesive which shall not require a liner for protection from contamination, preadhesion or blocking within the roll, or require activation procedures and shall adhere to asphaltic or portland cement concrete surfaces when applied according to manufacturer's recommendations at surface temperatures down to 35°F. The material shall be thin, flexible and formable, and following application shall remain conformed to the texture of pavement surfaces. Average thickness of material, as determined by 5 micrometer readings shall not be less than 9 mils. Minimum refectivity for material shall be 0.18 candlepower per footcandle per square foot when tested at a divergence angle of 0.2° and an incidence angle of 86° following the procedure described in DOTD Designation: TR 625. Striping tape shall be removable by following the manufacturer's recommendations so long as the material is substantially intact, and in no case shall removal require sandblasting, solvent or grinding methods and shall not result in objectionable staining of pavement surface.

1015.09 RAISED PAVEMENT MARKERS. Markers shall be either Class I — nonreflectorized or Class IV — reflectorized. Markers shall be an approved product on the Qualified Products List. Infrared curves of the materials used in the markers shall match approved curves on file at the Materials Section. Colors shall be as specified.

(a) Description:

(1) Class I markers shall consist of an acrylonitrile-butadiene-styrene polymer or approved equal. Class I-A markers shall be 4'' wide x 12'' long. Class I-B markers shall be 4'' wide x 6'' long. Class I markers shall be used primarily for traffic rumble strips.

(2) Class IV markers shall consist of acrylonitrile-butadiene-styrene or methyl methacrylate body or shell filled with a mixture of an inert thermosetting compound and filler material, or approved equal. The reflecting system shall consist of prismatic reflector lens or spherical reflecting system with biconvex glass elements, or approved equal. Class IV markers shall be used primarily for delineation of traffic lanes.

(b) Physical Requirements: All markers shall conform to the following requirements when tested in accordance with DOTD Designation: TR 621.

Property	Requirement
Heat Resistance	No change in shape or appearance
Impact Resistance	No break, chip or crack
Load Resistance	No break, chip, crack or permanent deformation

(c) Optical Requirements: Class IV markers shall conform to the following requirements when tested in accordance with DOTD Designation: TR 604.

	Footlamberts			
	Angle of Incidence			
Color	0°		20°	
	Average	Minimum	Average	Minimum
Crystal	125	100	60	50
Amber	80	65	35	25
Red	25	15	15	10

The reflectivity of the marker shall be not less than 80% of the above minimum values after being subjected to the heat test required elsewhere herein.

(d) Adhesive: The adhesive shall be a two component system con-

sisting of the epoxy resin and hardener. Equal parts, by volume, of the epoxy resin and hardener components must be mixed together to obtain the finished adhesive.

The adhesive shall be specified by the supplier as being either standard set or rapid set and shall conform to the following requirements when tested in accordance with DOTD Designation: TR 616.

Property	Requirement	
	Standard Set	Rapid Set
Pot Life at 77°F ± 2°F		
a. Mixture mixed and dispensed by machine, Minutes, Minimum	6	6
b. Mixture mixed and dispensed by hand methods, Minutes	7-13	Not Allowed
Set Time to reach 180 psi at 77°F ± 2°F, Minutes, Minimum	210	40
Slant Shear Strength, (base area), minimum, psi		
24 hrs. at 77°F ± 2°F	2000	1000
24 hrs. at 77°F ± 2°F, Plus water soak	1500	800
Viscosity at 77°F ± 2°F		
Component A (resin), poises	1000 to 3000	1000 to 3000
Component B (hardener), poises	1000 to 3000	1000 to 3000
Shear ratio, Minimum	2.0	2.0

1015.10 THERMOPLASTIC PAVEMENT MARKINGS.

(a) Description: This specification covers spray or hot extruded reflective thermoplastic compound for pavement markings on asphaltic and portland cement concrete pavement. The material shall be so manufactured as to be applied by spray or extrusion means to the pavement in molten form, with internal and surface application of glass spheres, and upon cooling to normal pavement temperature, shall produce an adherent, reflectorized pavement marking of specified thickness and width and capable of resisting deformation.

(b) General Characteristics: The compound shall not deteriorate because of the oil content of pavement materials or from oil droppings from

traffic. In the plastic state, materials shall not give off fumes which are toxic or otherwise injurious to persons or property. The material shall not break down or deteriorate if held at the plastic temperature for a period of four hours, or by reason of four reheatings to the plastic temperature. The temperature versus viscosity characteristics of the plastic material shall remain constant throughout up to four reheatings, and shall be the same from batch to batch. There shall be no obvious change in color of the material as the result of up to four reheatings or from batch to batch. To insure the best possible adhesion, the compound shall be installed in a melted state, at a minimum temperature of 380°F and the material shall not scorch or discolor if kept at this temperature for up to four hours.

(1) **Material Composition:** The binder shall consist of a mixture of synthetic resins, at least one of which is solid at room temperature. The total binder content of the thermoplastic compound shall be not less than 15 percent, nor more than 35 percent by weight. The pigmented binder shall be well dispersed and free from all skins, dirt, foreign objects or such ingredients as will cause bleeding, staining or discoloration. The filler shall be a white calcium carbonate or equivalent filler with a compressive strength of 5,000 psi.

(2) **Suitability for Application:** The thermoplastic material shall be a product especially compounded for pavement markings. The markings shall maintain their original dimension and placement and shall not smear or spread under normal traffic conditions at temperatures below 140°F. The marking shall have a uniform cross-section. Pigment shall be evenly dispersed throughout the material. The density and character of the material shall be uniform throughout its thickness. The exposed surface shall be free from tack and shall not be slippery when wet. The material shall not lift from the pavement in freezing weather. Cold ductility of the material shall be such as to permit normal movement with the road surface without chipping or cracking.

(3) **Drying Time:** The drying time shall not exceed a characteristic straight line curve, the lower limits of which are two minutes at 50°F, the upper limits of which are fifteen minutes at 90°F, both temperatures measured at a maximum relative humidity of 70 percent. After application and proper drying time, the material shall show no appreciable deformation or discoloration under traffic conditions, and in air or road temperature ranging from 0° to 140°F.

(4) **Color:** White reflectorized thermoplastic material shall have a pigment containing 8 to 10 percent titanium dioxide and, after setting, shall be pure white and free from dirt or tint. Yellow reflectorized thermoplastic material shall be "Federal Yellow" in color (Federal Test Method Standard 141a, Method 4252). The material shall not change its color and brightness characteristics after prolonged exposure to sunlight.

(5) Reflectorization: During manufacture, reflectorizing glass spheres shall be mixed into the material to the extent of not less than 15 percent nor more than 50 percent by weight of material. Glass spheres shall also be automatically applied to the surface of the material at a uniform rate of a minimum of 3 pounds of glass spheres to every 100 square feet of line. The glass spheres shall be dropped onto the thermoplastic material while it is in a molten state immediately after it has been applied to the pavement.

(c) Physical Requirements:

(1) Color:

White: Initially white as demonstrated by a standard color difference meter such as the Gardner Color Difference Meter standard not greater than the following:

Reflectance (Rd)	70% minimum
Redness — Greenness, a	0 ± 5%
Yellowness — Blueness, b	0 ± 10%

Yellow: Initially yellow equal to standard color chips, using Federal Test Method Standard 141a, Method 4252.

(2) Color Retention: The retention of the initial color may be determined by testing. Specimens shall be prepared in accordance with ultraviolet light ASTM methods which shall be a 275-watt sunlamp bulb, type RS, with built-in reflector. After 100 hours of exposure, specimens shall show no perceptible color change when compared visually with an unexposed specimen.

(3) Water Absorption: Materials shall have no more than 0.5% by weight of retained water when tested by ASTM Designation: D 570, procedure 6.1.

(4) Softening Point: Materials shall have a softening point of not less than 90°C, as determined by ASTM Designation: E 28.

(5) Specific Gravity: Specific gravity of the thermoplastic compound at 25°C shall be from 1.8 to 2.5.

(6) Impact Resistance: The impact resistance shall be not less than 10 inch-pounds at 77°F after the material has been heated for 4 hours at 400°F and cast into bars of 1 square inch cross-sectional area 3 inches long and placed with 1 inch extending above the vise in a cantilever beam (Izod type) tester, using the 25 inch-pound scale. This instrument is described in ASTM Designation: D 256.

(7) Bond Strength: The bond strength shall be not less than 50 psi when tested in accordance with DOTD Designation: TR 622.

(8) Indentation Resistance: When tested in accordance with ASTM

Designation: D 2240, the material shall conform to the following requirements. After heating the material for 4 hours at 400°F and cooling to the test temperature, the minimum durometer hardness using a 1 kg. (2.205 lb.) weight for 15 seconds shall be:

Durometer Type	Hardness	Test Temperature
A	65	115°F ± 3°F
D	95	77°F ± 3°F

(d) Properties of Glass Spheres for Reflectorization:

(1) Refraction Index: The glass spheres used in the formulation shall have a refractive index of not less than 1.50 when tested by the liquid immersion method at 25°C. At least 70 percent by count shall be water-white true spheres, free from air inclusions.

(2) Gradation: A sieve analysis of glass spheres shall be made in accordance with ASTM Designation: D 1214 and shall meet the following gradation requirements:

For compounding in the manufacture of the thermoplastic material:

U.S. Sieve No.	% Passing
40	80 to 100
80	0 to 10

For application on the molten thermoplastic material:

U.S. Sieve No.	% Passing
20	90 to 100
80	0 to 10

(3) Chemical Resistance: The glass spheres shall withstand immersion in water and acids without undergoing noticeable corrosion or etching and shall not be darkened or otherwise noticeably decomposed by sulfides. The tests for chemical resistance shall consist of one hour immersion in water and in solutions of corrosive agents, followed by microscopic inspection. A 3 to 5 gram portion of the sample shall be placed in each of three pyrex-glass beakers or porcelain dishes; one sample shall be covered with distilled water, one with 3N solution of sulfuric acid and the other with a 50 percent solution of sodium sulfide. After one hour of immersion, the glass spheres of each sample shall be examined microscopically for evidence of darkening and frosting.

(4) Packaging: Glass spheres used in drop-on application to the molten stripe shall be shipped in bags of multi-ply paper or burlap with a polyethylene liner, strong enough to permit multiple handling without

damage, and having a capacity of 50 pounds of spheres. The bags shall be sufficiently water resistant so that the spheres will not become wet or caked in transit.

Section 1016

Reinforced Concrete Units

1016.01 DESCRIPTION. This specification covers the manufacture of precast reinforced concrete catch basins, drop inlets and manhole units. The finished units shall conform to the dimensions shown on the plans.

1016.02 MATERIALS. The materials shall conform to the following Sections.

Portland Cement Concrete, Class P (Air-Entrained)	901
Reinforcing Steel	1009

1016.03 MANUFACTURE.

(a) Testing and Inspection: Acceptability of the units will be determined by the results of compression tests on concrete cylinders and by inspection during manufacture to determine their conformance with the design and workmanship prescribed in these specifications and on the plans.

The units shall attain a strength of 3,000 psi before moving and 4,000 psi prior to shipping.

The units shall be considered ready for acceptance regardless of age when they conform to the strength requirements, as indicated by the specified tests.

The manufacturer shall furnish all facilities and assistance required to carry on the sampling and testing in an expeditious and satisfactory manner.

(b) Reinforcement: Reinforcement shall be as shown on the plans, with the following permissible variations in position:

Except at pipe connections, variations in the position of the reinforcement shall not exceed ¼ inch from the position shown in the design. The cover on the reinforcement shall not be less than that shown on the plans.

(c) Casting: When multiple castings are to be made using the same forms, form material shall be meta[1]. The concrete in each sectional unit shall be placed without interruption, and shall be consolidated by the use of an approved vibrator, supplemented by such hand-tamping as may be

necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets or cleavage planes.

Openings for Pipes: Each opening shall be 4 ± ½ inch larger than the outside diameter of the pipe for which it is provided.

Steps and Ladders: When steps are required, the steps that are cast or mortared into the walls shall be aligned in each section so as to form a continuous ladder with rungs equally spaced vertically in the assembled unit.

(d) Curing: The units shall be cured by steam curing or water curing methods as given herein for a sufficient length of time so that the concrete will develop the specified compressive strength.

(1) Steam Curing: The units may be steam cured as specified in Subsection 805.15(f).

(2) Water Curing: The units may be cured by being kept wet for not less than 72 hours under normal summer temperature conditions. In colder weather the water curing period shall be extended, as directed by the engineer, to provide equivalent curing. The units shall be protected from freezing from the time the concrete is placed and until curing is completed.

(e) Removal of Forms: The forms shall remain in place until they can be removed without damage to the unit.

(f) Workmanship: The units shall be true to shape and their surfaces shall be smooth, dense and uniform in appearance. When approved by the engineer, minor surface cavities or irregularities which do not impair the service value of the unit and which can be corrected without marring its appearance shall be pointed with approved mortar as soon as the forms are removed. Such minor defects shall not constitute cause for rejection.

(g) Compressive Strength: Compression tests for satisfying the minimum strength requirements shall be made on cylinders. A minimum of three cylinders will be made from each day's pour and cured in the same manner as the precast units.

(h) Rejection: Units shall be subject to rejection because of failure to meet any of the requirements specified above; and in addition, any of the following defects shall be cause for rejection.

(1) Defects that indicate imperfect mixing and molding.

(2) Defects indicating honeycombed or open texture.

(3) Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.

(i) Marking: The name or trademark of the manufacturer and date of casting shall be stenciled on the unit in such a manner as to be clearly legible at time of delivery.

(j) At the time it is approved by the inspector, each unit will be stamped with the official mark of the Department. The acceptance of any materials or finished units by the inspector shall not prevent them from being rejected later if they are found to be defective.

No unit shall be shipped or transported to the installation site unless it bears all the required markings.

(k) Testing: Method of test shall be in accordance with the following:

Compressive Strength — AASHTO Designation: T 22.

Section 1017

Miscellaneous Materials

1017.01 WATER FOR USE WITH CEMENT. Water for use with portland cement in mortar, concrete or base course that is obtained from an approved city water supply or is suitable for human consumption will not require testing; however, the source shall be noted by the engineer. Water obtained from other sources shall meet the following requirements, except that the salt (NaCl) requirements may be waived when used for base course.

Sugar	None
Oil	None
Acid	None
Alkali, Not Over	0.1%
Solids (Organic), Not Over	0.1%
Solids (Inorganic), Not Over	0.4%
Salt (NaCl), Not Over	0.5%

Water of questionable quality shall be subjected to the soundness test as specified in AASHTO Designation: T 26. The sample being tested shall show a strength of 90 percent of the comparative at 7 or 28 days of age.

1017.02 CALCIUM CHLORIDE. Calcium chloride shall conform to AASHTO Designation: M 144.

1017.03 HYDRATED LIME. Hydrated lime shall be from a source approved by the Department and shall conform to ASTM Designation: C 207, Type N, except maximum free moisture shall be 1½ percent.

1017.04 MANHOLE STEPS, FRAMES, GRATES AND COVERS. Metal units shall conform to the following requirements:

(a) Gray iron castings shall conform to Subsection 1013.06.

(b) Steel castings shall conform to Subsection 1013.05.

(c) Malleable iron castings shall conform to Subsection 1013.06.

(d) Galvanizing, where specified shall conform to AASHTO Designation: M 111.

(e) Manhole steps shall be from a source shown on the Qualified Products List.

1017.05 COTTON DUCK (Canvas). Cotton duck (canvas) shall be the weight specified and shall conform to AASHTO Designation: M 166.

1017.06 PREFABRICATED MASONRY PADS.

(a) Type A Pads: These pads shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high quality rubber compound, or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness after compression and vulcanizing.

The pads shall withstand compressive loads perpendicular to the plane of laminations of not less than 10,000 psi before breakdown. Load deflection properties in accordance with procedures of MIL-C-882C shall be the following maximum percentages of total pad thickness: 10 percent at 1000 psi, 15 percent at 2000 psi. When loaded to 1500 psi, permanent set as load is removed in accordance with procedures of MIL-C-882C shall be a maximum of 2.5 percent of the original "zero point" thickness. Shore "A" Durometer shall be 90 $\pm$ 5. The ratio of lateral expansion to vertical deflection shall not exceed 0.25 when loaded to 1500 psi. The material shall not lose effectiveness throughout a temperature range of -65°F to $+$ 150°F. There shall be no visual evidence of damage or deterioration by environmental effects of sunshine, humidity, salt spray, fungus and dust in accordance with MIL-E-5272C. Thickness shall not vary from that specified by more than $\pm$ 5 percent.

(b) Type B Pads: These pads shall consist of fabric and rubber body made from new unvulcanized rubber and new fabric fibers in proper proportion to maintain strength and stability.

The vulcanized and cured pad shall have a surface hardness of 80 Shore "A" Durometer $\pm$ 10 and shall be able to withstand a compressive load of 10,000 psi without excessive extrusion or detrimental reduction in thickness.

The thickness shall not vary from that specified by more than $\pm$ 1/32 inch.

(c) Sampling: Sampling of pads shall be in accordance with the Department's Materials Sampling Manual.

1017.07 TIMBER CONNECTORS. Connectors for treated timber structures, except those of malleable iron, shall be galvanized in accordance with ASTM Designation: A 123.

(a) Split Ring Connectors: Split rings of 2½ inch inside diameter, 4 inch inside diameter and 6 inch inside diameter shall be manufactured from hot rolled, low-carbon steel conforming to ASTM Designation: A 711, Grade 1015. Each ring shall form a closed true circle with an outside cylindrical surface parallel to the axis of the ring. The inside surface, except for the 6 inch ring, shall be beveled from the median line toward the edges. It

shall be cut through in one place in its circumference to form a tongue and slot.

Connector grooves in timber shall be cut concentric with the bolt hole and shall be of the following dimensions:

(1) **For 2½ inch split rings:** Inside diameter, 2.56 inches; width of groove, 0.18 inch; depth of groove, 0.37 inch.

(2) **For 4 inch split rings:** Inside diameter 4.08 inches; width of groove, 0.21 inch; depth of groove, 0.50 inch.

(3) **For 6 inch split rings:** Inside diameter, 6.12 inches; width of groove, 0.27 inch; depth of groove, 0.62 inch.

(b) Toothed-ring Connectors: Toothed-ring connectors shall be stamped cold from 0.060 inch thick rolled sheet steel conforming to ASTM Designation: A 711, Grade 1015, and shall be bent cold to form a circular, corrugated, sharp-toothed band and circle and shall be parallel to the axis of the ring. The central band shall be welded to fully develop the strength of the band. All sizes shall have an overall depth of 0.94 inch and depth of fillet of 0.25 inch.

(c) Shear Plate Connectors: Shear plate connectors shall be of the following types:

(1) **Pressed Steel Type:** Pressed steel shear plates of 2⅝ inch diameter shall be manufactured from steel conforming to ASTM Designation: A 711, Grade 1015. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one face only, the plate portion having a central bolt hole and 2 small perforations on opposite sides of the hole and midway from the center and circumference.

(2) **Malleable Iron Type:** Malleable iron shear plates of 4 inch diameter shall be manufactured according to ASTM Designation: A 47, Grade 35018. Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one face only, the plate portion having a central bolt hole reamed to size with an integral hub concentric to the bolt hole and extending from the same face as the flange.

(d) Claw-Plate Connectors: Claw-plate connectors of 2⅝ inch, 3⅛ inch and 4 inch diameter shall be of malleable iron, manufactured according to ASTM Designation: A 47, Grade 35018. Each claw-plate shall consist of a perforated circular flanged plate with 3-sided teeth arranged about the perimeter of one face. The male plate shall have integral cylindrical hubs on both faces concentric to a bolt hole through the center of the plate. The female plate shall be flat on the side opposite the teeth but shall have an integral cylindrical hub concentric to the central bolt hole and on the face with the teeth.

(e) Spike-Grid Connectors: Spike-grid connectors shall be manufactured according to ASTM Designation: A 47, Grade 35018. They shall consist of 4 rows of opposing spikes forming a 4⅛ inch square grid with 16 teeth which are held in place by fillets. Fillets for the flat grid in cross section shall be diamond shaped. Fillets for the single and double curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between the sloping faces of the fillets equal to the width of the fillet.

1017.08 HARDWARE AND STRUCTURAL SHAPES.

(a) Hardware: Machine bolts, drift bolts and dowels may be either wrought iron or medium steel. Washers shall be cast ogee gray iron or malleable castings, unless washers cut from medium steel plate are called for on the plans. A standard circular washer shall be used under the heads of all lag screws.

Machine bolts shall have square heads and nuts unless otherwise called for. Nails shall be cut or round wire of standard form. Spikes shall be cut wire or boat spikes. All bridge hardware shall be galvanized in accordance with ASTM Designation: A 153.

(b) Structural Shapes: All structural shapes, rods and plates shall be of structural steel conforming to Section 1013.

(c) Electrical Apparatus: All hardware for electrical apparatus shall conform to ASTM Designation: A 193, Grade B8 (bolts and studs) and ASTM Designation: A 194, Grade 8 or 8A (nuts).

1017.09 RIGID METAL CONDUIT (Electrical). Rigid metal conduit shall conform to ANSI Designation: C 80.1 or C 80.5.

1017.10 ELECTRICAL CONDUCTORS. Electrical conductors shall conform to IPCEA Pub. No. S-19-81, S-66-524 and S-61-402.

1017.11 ALUMINUM PLATE. Aluminum plate for use in construction of such items as junction boxes shall conform to ASTM Designation: B 209, Alloy 6061-T6.

1017.12 BARRICADE WARNING LIGHTS.

(a) General: Types A, B and C barricade warning lights shall be in accordance with the Louisiana MUTCD. All mountings on which these lights are attached, including the portable supports specifically for these lights, shall be reflectorized with encapsulated lens reflective sheeting as specified.

(b) Qualification: All lights used shall have prior approval and be listed on the Department's Qualified Products List. In order to obtain qualification one light of each type to be supplied shall be submitted to the Materials Engineer along with a certified test report from an independent testing laboratory listing the results for each requirement of the specifica-

tions. Approval from a state highway agency is acceptable in lieu of the latter requirement provided such approval is based on actual test results. The sample lights shall become the property of the Department for use as a control standard.

(c) Markings: Each light submitted for approval and each light placed on a project shall have permanently attached an identification plate or other permanent markings with the following information.

(1) Manufacturer's name
(2) Model number
(3) Type
(4) Lens manufacturer and identification number
(5) Circuit manufacturer and identification number
(6) Bulb number
(7) Minimum operating voltage required to conform to minimum intensity requirements
(8) Year of manufacture

(d) Acceptance: At the time of erection the contractor shall furnish the engineer with a notarized material certification listing (1) the proposed total number of warning lights to be used, (2) their type, (3) trade name and (4) the manufacturer's name and model number as contained on the Department's Qualified Products List. The certification shall also state that each light assembly has been tested prior to installation on the project and is functioning properly and shall be maintained in satisfactory working order.

(e) Testing: Lights used on projects will not require testing if listed on the Qualified Products List. Periodic spot checks will be made and failure of the samples to conform to specification requirements shall be cause for removal from the Qualified Products List. Lights shall be maintained so that the minimum operating voltage specified is available at all times.

1017.13 ROOFING PITCH. Roofing pitch shall conform to AASHTO Designation: M 118.

1017.14 ELASTOMERIC BRIDGE BEARING PADS.

(a) General: The elastomer portion of the compound used for bearings shall be 100 percent virgin chloroprene stock. Natural rubber, vulcanized rubber (natural or synthetic) or other synthetic rubber-like materials will not be acceptable.

Nonelastic laminates shall be a nominal 1/16 inch thick rolled steel sheets conforming to either ASTM Designation: A 570 (c or d) or A 606.

(b) Physical Properties of Elastomer: The elastomer compound for plain and laminated bearings shall meet the requirements in Table XV. Insofar as possible, all tests shall be made on the finished product. A deviation of minus 10 percent from the values in Table XV will be allowed on

the original tensile, original elongation and tear properties where tests are performed on samples taken from the finished product. Special molded or prepared specimens, where required, shall conform to the specimen preparation requirements of the particular test involved.

Table XV
PHYSICAL PROPERTIES

	Grade (Durometer)		
	50	**60**	**70**
Original Physical Properties			
Hardness, ASTM Designation: D2240	50 ± 5	60 ± 5	70 ± 5
Tensile Strength, Minimum psi, ASTM Designation: D 412	2,500	2,500	2,500
Elongation at Break, Minimum Percent	400	350	300
Accelerated Test to Determine Long-Term Aging Characteristics, Oven-aged, 70 Hours/212°F, ASTM Designation: D 573			
Hardness, Points Change, Maximum	0 to + 15	0 to + 15	0 to + 15
Tensile Strength, % Change, Maximum	± 15	± 15	± 15
Elongation at Break, % Change, Maximum	− 40	− 40	− 40
Ozone — 100 ± 5 PPHM in Air by Volume — 20 % Strain or Bent Loop — 104°F, ASTM Designation: D 1149* 100 Hours	No Cracks	No Cracks	No Cracks
Compression Set — 22 Hours/158°F, ASTM Designation: D 395 — Method B, Percent Maximum	25	25	25
Low Temperature Test** Brittleness − 40°F ASTM Designation: D 746, Procedure B	No Failure	No Failure	No Failure
Adhesion (for laminated bearings)** Bond made during vulcanization, ASTM Designation: D 429, Method B, Lbs. per inch, Minimum	40	40	40

* Sample to be solvent wiped before test to remove any traces of surface impurities.

** Manufacturer's certification of this requirement and routine testing may be waived at option of the Department.

(c) Formulation, Prequalification and Certification: All bearing pads shall be produced by a manufacturer listed on the Department's Qual-

ified Products List. Each hardness of elastomer formulation produced by a manufacturer must be approved by the engineer prior to its first use on Department projects.

In order to obtain initial prequalification approval of a particular formulation, the bearing manufacturer shall submit to the engineer well in advance of anticipated use certified test results indicating actual test values obtained on the physical properties of the elastomer for compliance with the specifications.

In addition, the manufacturer shall forward prequalification test samples to the Department's Materials Laboratory for testing, evaluation and possible subsequent written approval indicating compliance with prequalification requirements. These prequalification samples shall consist of at least two sets of cut specimens as required by the ASTM specifications stipulated in Table XV. In addition to the required ASTM samples, at least one finished bearing, typical of the size and type intended to be furnished on Department projects, shall be submitted for prequalification testing. All samples shall be produced from factory mixed stock.

In the case of laminated bearings, one finished laminated bearing, typical of the size and type to be subsequently furnished on Department projects, shall be submitted for prequalification testing.

The engineer may require that the complete testing procedure for prequalification purposes be performed again by the producer during later production.

(d) Manufacturing Requirements: All components of a laminated bearing shall be molded together into an integral unit. All edges of the non-elastic laminations shall be covered by a minimum of ⅛ inch of elastomer. Unless otherwise shown on the plans, all laminates shall be parallel with the bottom surface of the bearing, subject to the tolerances that follow.

The preparation of elastomer compound prior to placement in the mold shall be such as to result in a homogeneous finished bearing pad free of voids, blisters, cracks, folds, cuts, nonfills and any appearance of layers or ply separation on the surface or within the pad. Plain bearing pads may be molded individually or cut to length from previously molded strips or slabs. No pads shall be formed from the lamination of previously cured sheets or slabs. The finish of cut surfaces shall be at least as smooth as ANSI No. 250 finish.

The batch or lot number shall be marked on each bearing in such a manner as to remain legible until the bearing is placed in the structure. A batch is defined as the quantity of compound produced from each separate mixture of ingredients. A lot is defined as the quantity of compound resulting from the mixture of two or more batches.

(e) Appearance and Dimensions: Flash tolerance and appearance shall

conform to Drawing Designation RMA-F3-T.063 of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc.

For both plain and laminated bearings the permissible variation from the dimensions and configuration specified shall be as follows:

1. Overall Vertical Dimensions
   Average Total Thickness 1¼ in. or Less ..... − 0, + 1/8″
   Average Total Thickness over 1¼ in. ..... − 0, + 1/4″
2. Overall Horizontal Dimensions ..... − 0, + 1/4″
3. Thickness of Individual Layers of Elastomer
   (Laminated Bearings Only) ..... ± 1/8″
4. Variation from a Plane Parallel to the
   Theoretical Surface
   Top ..... 1/8″
   Sides ..... 1/4″
   Individual Nonelastic Laminates (determined by
   measurements at edges of bearing) ..... 1/8″
5. Position of Exposed Connection Members ..... 1/8″
6. Edge Cover of Embedded Laminates or
   Connection Members ..... − 0, + 1/8″
7. Size of Holes, Slots or Inserts ..... − 0, + 1/8″
8. Position of Holes, Slots or Inserts ..... 1/8″
9. Thickness of Nonelastic Laminates ..... − 0, + 1/16″

(f) After prequalification approval, one plain bearing and/or one laminated bearing will be taken by the engineer at random from each project or from each batch or lot of elastomer; however, not less than one sample per 100 bearings will be furnished. These bearings will not be returned for use on the project, and no direct payment will be made for the bearing samples.

Also, the actual certificates of analysis showing test results that are used in quality control by the manufacturer shall be furnished to the engineer. These quality control tests shall be taken per batch or lot from factory mixed stock used to produce the finished bearing.

For laminated bearings only, each bearing shall be subjected, by the manufacturer, to an average compression of 1,000 pounds per square inch of bearing area in the presence of the Department's inspector. The performance of each bearing will be considered satisfactory provided there is no visible evidence of bond failure or other damage to the bearing because of this loading.

1017.15 PLASTIC FILTER CLOTH.

(a) General Requirements: Plastic filter cloth shall consist of linear polypropylene or polyethylene monofilament yarn woven into sheets of 20 to 30 mils thickness. The lengths and widths of sheets may be varied to suit the manufacturer's standards. Seams meeting strength requirements of the

plastic filter cloth will be permitted. Additional yarn of other material or steel wire may be woven into the cloth to increase overall strength.

The plastic filter cloth shall be an approved product on the Qualified Products List. The same product shall be used throughout the project.

(b) Detailed Requirements: The plastic filter cloth shall conform to the following requirements:

Property	Requirements	Test Method
Thickness	20-30 mils	
Weight	5-10 oz./yd.^{2}	ASTM D1910
Open Area	20-30%	
Equivalent Opening Size (U.S. Sieve)	45-35	
Tensile Strength		
Warp	200 lbs./in.	ASTM D1682
Fill	200 lbs./in.	ASTM D1682
Burst Strength	500 psi	
Abrasion Resistance		
Stoll (2-lb. head, 3 psi air, 0 grit)	9,000 cycles to failure	ASTM D1175
Taber (CS-17 abrasive wheels, 1000 grams load per wheel)	4,500 cycles to failure	ASTM D1175

Fibers of other composition or steel wire may be woven into the cloth for reinforcing purposes. The durability of these fibers must be equivalent to that of the plastic filter cloth.

(c) Permeability and Filtration: A certified copy of permeability and filtration tests from a qualified laboratory showing the performance of this filter with fine sands and water, stating both particle retention and permeability, shall be included with a sample of the material.

1017.16 COMMERCIAL FERTILIZER. All fertilizers shall be commercial type conforming to the commercial fertilizer laws in effect as issued by the Louisiana Department of Agriculture. The chemical composition shall be as specified and shall be designated by a 3-number sequence representing minimum percentages by weight, respectively, of nitrogen (N), available phosphoric acid (P_2O_5) and soluable potash (K_2O). Fertilizer shall be supplied in granulated or pelletized form and shall be packaged in suitable containers to prevent contamination by moisture.

1017.17 AGRICULTURAL LIME. Agricultural lime shall consist of ground limestone or seashells containing at least 90 percent calcium carbonate equivalent ($CaCO_3$) and not more than 10 percent magnesium car-

bonate ($MgCO_3$). The material shall be ground so that 100 percent must pass a No. 8 sieve and a minimum of 30 percent must pass a No. 100 sieve.

1017.18 SEEDING. All seed shall conform to all requirements, rules and regulations of Chapter II, Title 3 of Louisiana Revised Statutes of 1950. The minimum percentage of pure live seed and the maximum percentage of weed seed permitted shall be in accordance with Table XVI herein.

Each variety of seed shall be furnished and delivered in separate bags or other containers. Each bag or container shall bear an analysis tag which shall conform to the Rules and Regulations as promulgated by the Louisiana Seed Commission for the enforcement of the Louisiana Seed Law (Acts 372 of 1946 and 1952).

The analysis tag shall be a No. 6 standard shipping tag, minimum size, and shall carry the information required by the Louisiana Seed Law, arranged as shown in Illustration No. 1 and in addition, shall carry the Laboratory number of the Louisiana Department of Agriculture for that particular lot number shown on tag.

All seed furnished shall be the previous season's crop and the date of analysis shown on each tag shall be within 6 months of the time of delivery to the project.

TABLE XVI

Variety of Seed	Min. Percentage of Pure Live Seed (Purity Times Germination Including Hard Seed)	Max. Percentage of Weed Seed Permitted
Hulled Bermuda.....	86	1
Carpet Grass	76	2
Pensacola Bahia.....	81	2
Dixie Crimson Clover	82	1
Kentucky 31 Fescue	82	1

(a) Noxious Weeds: Noxious weeds shall be interpreted to mean that list of weeds, except bermuda, which has been approved and adopted by the Louisiana Seed Commission as being noxious in Louisiana. The total of all noxious weed seed shall not exceed 500 per pound.

Analysis tags shall be removed from each bag or container only by the engineer or his authorized representative.

(b) Test Report: A copy of the laboratory test report of an "official" sample for each lot of seed furnished as prepared by the State Seed Analyst

of the Louisiana Department of Agriculture shall be submitted to the engineer by the contractor. The Department will accept test reports from other states provided the requirements of these specifications are met.

Illustration No. 1

La. Dept. of Agriculture
Kind & Variety _____ Laboratory No. _____
Where Grown _____ Net Wt. _____ Lot No. _____
Pure Seed _____ % Germination _____ %
Inert Matter _____ % Hard Seed _____ %
Crop Seed _____ % Total Germ. & Hard Seed _____ %
Weed Seed _____ % Date of Test _____
Name & No. of Noxious Weed Seed per lb. _____

Name _____
Address _____

1017.19 VEGETABLE MATERIAL FOR MULCH. Mulch shall be vegetative in character and shall consist of either stems or stalks of oats, rye, rice, wheat or other approved straws. The contractor may also use hay obtained from various legumes and grasses such as lespedezas, clover, vetches, soybeans, bermuda, Dallis, carpet sedge, fescue or other approved legumes of grasses of any combination thereof. Straw or hay shall be reasonably dry and free from mold, Johnson grass or other noxious weeds.

1017.20 FIBER GLASS ROVING.

(a) Description: This specification covers a continuous fiber glass roving used in combination with asphalt or other cementitious materials to control erosion on newly seeded slopes and drainage channels.

(b) General Requirements: The material shall be formed from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into roving without the use of clay, starch or like deleterious substances. The roving shall be wound into a cylindrical package approximately 1 foot high in such a manner that the roving can be continuously fed from the center of the package through an ejector driven by compressed air and expanded into a mat of glass fibers on the soil surface. The material shall contain no petroleum solvents or other agents known to be toxic to plant or animal life.

(c) Detailed Requirements: The fiber glass roving shall conform to the following requirements:

Property	Alternate Limits		Test Method
Strands/Rove	28-32	56-64	End Count
Fibers/Strand	368-468	184-234	
Fiber Diameter, in. (Trade Designation — G)	0.00035-0.0004	0.00035-0.0004	ASTM D 578
Yards/lb. of Strand	6,500-7,000	13,000-14,000	ASTM D 578
Yards/lb. of Rove	195-230	195-230	ASTM D 578
Organic Content, Percent maximum	0.75	0.75	ASTM D 578
Package Weight, lbs.	28-37	28-37	ASTM D 578

1017.21 BAGS FOR SACKED CONCRETE.

(a) Description: This specification covers the bags to be used in sacked concrete for a flexible revetment system.

(b) General Requirements: Bags shall be suitable new burlap bags, approved heavy duty reinforced Kraft shipping sacks or other approved material.

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