State of Louisiana

DEPARTMENT OF HIGHWAYS

Standard Specifications for Roads and Bridges

BATON ROUGE

JULY, [illegible]

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State of Louisiana

DEPARTMENT OF HIGHWAYS

Standard Specifications for Roads and Bridges

BATON ROUGE

JULY 1955

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DIVISION I

DIVISION I

SECTION 1

DEFINITION OF TERMS

1.01 Definitions:

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

1.02 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:

A.A.N......American Association of Nurserymen
A.A.R......Association of American Railroads
A.A.S.H.O......American Association of State Highway Officials
A.I.A......American Institute of Architects

A.I.S.C. ..... American Institute of Steel Construction
A.R.A. ..... American Railway Association
A.R.E.A. ..... American Railway Engineering Association
A.S.A. ..... American Standards Association
A.S.C.E. ..... American Society of Civil Engineers
A.S.L.A. ..... American Society of Landscape Architects
A.S.T.M. ..... American Society for Testing Materials
A.W.P.A. ..... American Wood-Preservers Association
A.W.W.A. ..... American Water Works Association
A.W.S. ..... American Welding Society
F.S.S.C. ..... Federal Standard Stock Catalog, Treasury Department
PUBLIC ROADS ..... Bureau of Public Roads, Department of Commerce
S.A.E. ..... Society of Automotive Engineers

1.03 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 service roads.

1.04 Bidder:

Any individual, firm or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.

1.05 Bridges:

Any structure, including multiple spans, of over 20 feet total length carrying the roadway, measured under the copings, and parallel to the center of the road. The width of bridges is the distance between inside faces of curb.

1.06 Bridge Complete:

The entire structure, including both substructure and superstructure.

1.07 Contract:

The written agreement between the Department and the contractor covering the performance of the work and the furnishing of labor, materials, tools, equipment and incidentals necessary for the completion of same. The contract shall be mutually understood to include "Plans," "Specifications," "Special Provisions," "Notice to Contractors," "Proposal" and "Contract Bond," also any and all "Supplemental Agreements" which are required to complete the construction of the work in a satisfactory and acceptable manner.

1.08 Contract Bond:

The approved form of security furnished by the contractor and his surety as a guarantee for the proper performance of the work and payment for all materials or other obligations contracted by him in the prosecution thereof.

1.09 Contract Day:

A contract day, for the purpose of this contract, is an arbitrary empirical unit adopted, in lieu of the calendar day, for the purpose of accounting contract time.

1.10 Contract Item (Pay Item):

An item of work specifically described and for which a price, either unit or lump, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials, described in the text of a specification item included in the contract or described in any subdivision of the supplemental specifications or special provisions of the contract.

In these specifications, or in the supplemental specifications thereto, contract items are numbered to correspond to the Parts and Sections thereof contained in Division II. The first digit of the number represents the "Part," the second digit the "Section," and the third digit the "Identifying Number" applying thereto. Each contract item shall be constructed under the specifications contained in the part and section of the corresponding number.

Item numbers carrying a suffix letter are covered in the special provisions and are appropriately referenced therein.

Pay items appearing in the proposal and contract for which no corresponding "section" or "identifying numbers" appear in these specifications are special items and are covered fully in the special provisions.

1.11 Contractor:

Party of the second part to the contract, acting directly or through his agents or employees, or the surety in case of default.

1.12 Culverts:

All waterway structures not defined as bridges.

1.13 Department:

Louisiana Department of Highways, acting through the Director of Highways.

1.14 Director:

Director of Louisiana Department of Highways.

1.15 Divided Highway:

A highway with separated roadways for traffic in opposite directions.

1.16 Engineer:

The Chief Engineer of the Louisiana Department of Highways, or his authorized representative, limited by the particular duties entrusted to him. When the term "Chief Engineer" is used, it shall mean the chief engineer in person.

1.17 Equipment:

All machinery implements, power tools and live stock, together with the necessary supplies for the operation, upkeep and maintenance of same and also all other tools and apparatus necessary for the proper construction and acceptable completion of the work.

1.18 Extra Work Order:

A written agreement on an approved form signed by the contractor and the Chief Engineer, involving changes

or additional work within the provisions of the contract and not considered of sufficient importance to require a "Supplemental Agreement."

1.19 Grade Separation:

Any structure carrying highway traffic over or under another highway or street, or over or under a railroad crossing.

1.20 Highway:

The entire right of way devoted to public travel and accessible to the public.

1.21 Inspector:

An authorized representative of the engineer, assigned to make any and all inspections of the work performed and materials furnished by the contractor.

1.22 Laboratory:

The official testing laboratories of the Department or such other laboratories as may be designated by the Chief Engineer.

1.23 Materials:

Any substance used in connection with the construction of any structure or the roadway and its appurtenances, provided, however, that this term shall not include material used in falsework or other temporary structures but not incorporated in the improvement.

1.24 Median:

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

1.25 Pavement:

The combined base and wearing course, considered as a single unit.

1.26 Plans:

The official approved plans, profiles, typical cross sections, general cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions and details of the work

to be done, and which are to be considered as a part of the contract supplementary to these specifications.

1.27 Project Engineer:

An engineer in charge of one or more specified projects.

1.28 Project Number:

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

1.29 Proposal:

The written offer of the bidder to perform the contemplated work and furnish the necessary materials, when made out and submitted on the prescribed proposal form, properly signed and guaranteed.

1.30 Proposal Guaranty:

The security designated in the "proposal form" to be furnished by the bidder as a guaranty of good faith to enter into a contract with the Department, if the contract is awarded to him.

1.31 Right of Way:

The entire area of land which is acquired and reserved for use in constructing, maintaining and protecting the highway and its structures and appurtenances, including improvement of the roadside.

1.32 Roadbed:

That portion of the roadway included between the inside edges of slopes of ditches in cuts and tops of fill slopes on embankments; the "surfacing" plus the "shoulders."

1.33 Roadway:

That portion of the right of way included between the outside lines of slopes, gutters, or side ditches, including also the appertaining structures, and all slopes, ditches, channels, waterways, etc., necessary to proper drainage and protection.

1.34 Service 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.

1.35 Shoulders:

That portion of the roadbed between the surfacing and the top of the side slopes of the roadbed.

1.36 Special Provisions:

The specific clauses or provisions setting forth conditions, or requirements, peculiar to the project under consideration and covering work, or materials, involved in the proposal and estimate, but not thoroughly or satisfactorily stipulated or set forth by the Standard Specifications.

1.37 Specifications:

The directions, provisions and requirements contained herein, which are designated as "Louisiana Standard Specifications for Roads and Bridges," as supplemented by such "Special Provisions" and "Supplemental Agreements" as may be necessary, pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the contract.

The subject matter in these specifications has been divided into 5 divisions. Divisions I, III, IV and V are general and apply, where applicable, to all contracts and agreements entered into by the Louisiana Department of Highways unless the contract or agreement specifically provides otherwise.

Division II is divided into parts and is specific in nature. The parts, sections and items therein apply only when a specific reference is made thereto in the contract.

Special provisions modifying or changing the Standard Specifications will be appropriately referenced.

1.38 State:

The State of Louisiana.

1.39 Structures:

Bridges, culverts, headwalls, end walls and incidental construction such as catch basins, drop inlets, manholes, retaining walls, and other construction which may be encountered in the work and not otherwise classified herein.

1.40 Subcontractor:

Any individual, firm, partnership, or corporation who contracts with the contractor, with the written consent of the Department, to perform any part of the project covered by the contract.

1.41 Subgrade:

The portion of the roadbed prepared as a foundation for the base and surface courses.

1.42 Substructure:

All of that part of the structure below the bridge seats or below the spring lines of arches. Parapets, backwalls and wingwalls of abutments shall be considered as parts of the substructure.

1.43 Superstructure:

All of that part of the structure above the bridge seats or above the spring lines of arches and not included in the substructure.

1.44 Supplemental Agreement:

A written agreement between the Department and the contractor involving changes in the contract plans and/or specifications, with the assent of the contractor's surety, which when duly executed becomes a part of the contract.

1.45 Surety:

The corporate body licensed to do business in Louisiana which is bound with and for the contractor, who is primarily liable, and which engages to be responsible for his payment of all obligations pertaining to and for his acceptable performance of the work for which he has contracted.

1.46 Temporary Structures:

Any temporary structures or stream crossings required to maintain traffic while constructing or reconstructing structures or parts of structures covered by the contract. The temporary structures shall include the earth approaches thereto.

1.47 The Work:

All work specified herein or indicated on the plans as the contemplated improvement, covered by the contract.

1.48 Through and Local Traffic:

(a) Through traffic is that traffic emanating from without one limit of the project and having as its destination some point beyond the other limit of the project.

(b) Local traffic is that traffic emanating from without the limits of the project and having as its destination some point or points within the limits of the project or emanating from within the limits of the project and having as its destination some point or points either within or without the limits of the project.

1.49 Traffic Lane:

The portion of a traveled way for the movement of a single line of vehicles.

1.50 Work Order:

A written notice from the engineer notifying the contractor to begin the prosecution of the work.

SECTION 2

PROPOSAL REQUIREMENTS AND CONDITIONS

2.01 Notice to Contractors:

After the time and place have been fixed for the receipt of proposals, the Department will publish an advertisement giving notice of a request for bids. The advertisement will contain a description of the project; a statement of the place where bids will be received and the time for opening same; instructions to bidders as to access to plans, specifications and proposals; and the District Engineer or his authorized representative qualified to show the work.

2.02 Contents of Proposal Forms:

Bidders will be furnished with proposal forms which will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities of work to be performed and materials

to be furnished, with a schedule of items for which unit prices are asked, and the date and time and place of the opening of the proposals. The "Notice to Contractors" and the "Special Provisions" will be attached to the proposal form. All papers bound with or attached to the proposal form are a necessary part thereof and must not be detached or altered.

2.03 Interpretation of Estimates:

The quantities listed in the proposal form are to be considered as approximate and are to be used only for the comparison of bids. Payment to the contractor will be made only for the actual quantities of work performed and materials furnished in accordance with the contract, and if, upon completion of the construction, the actual quantities shall show either increase or decrease from the quantities given in the approximate estimate, the unit bid prices mentioned in the proposal will still prevail, except as otherwise herein provided.

2.04 Examination of Plans, Specifications, Special Provisions and Site of Work:

The bidder is required to examine carefully the site of the proposed work, proposal, plans, specifications, special provisions and contract and bond form for the work contemplated, and it will be assumed that he has investigated and satisfied himself as to the conditions to be encountered, as to the character, quality and quantities of work to be performed and materials to be furnished, and as to the requirements of these specifications, special provisions and contract. Bidders are assumed to have made themselves familiar with all federal and state laws, local laws, ordinances and regulations which in any manner affect the work or its prosecution. The filing of a bid shall be presumptive evidence that the bidder has complied with these requirements.

2.05 Preparation of Proposal:

The bidder must submit his proposal on the prescribed form and the blank spaces in the proposal must be filled in correctly, where indicated, for each and every item for which a quantity is given, and the bidder must state the prices (written in ink, both in words and numerals), for

which he proposes to do each item of the work contemplated. Bidders are required to examine carefully the proposal form before submitting same in order to see that a unit price is submitted on each and every item on which all bidders are required to submit a bid. The bidder will be responsible for all errors or omissions in his proposal and if a bidder fails to submit a unit price for any item or items upon which a bid is required, his proposal shall be completed by the insertion of the lowest unit price or prices submitted for the item or items in any regular formal bid on the project. Such a unit price or prices shall be used in the contract, if awarded, as if originally submitted. In case of a conflict between the written unit price and the unit price in figures, the written unit price shall govern. Should the written unit price be illegible, the unit price in figures shall govern. The bidder shall sign his proposal correctly. If the proposal is made by an individual, his name and post office address must be shown. If made by a firm or partnership, the name and post office address of each member of the firm or partnership must be shown. If made by a corporation, the person signing the proposal must show the name of the State under the laws of which the corporation was chartered and the names, titles and business address of the president, secretary and treasurer and, if required, the one signing the proposal as the agent of a firm or corporation must furnish legal evidence that he has a rightful authority to such signature, and that the signature is binding upon the firm or corporation. Proposals must be signed in ink.

Where the successful bidder is a person or group of persons carrying on, conducting or transacting any business in this State under an assumed name, or under any designation, name or style, corporate or otherwise, other than the real name or names of the individual or individuals conducting or transacting such business, the Department shall be furnished a certificate (as provided by law) from the Registrar of Conveyances in the City of New Orleans, or the Clerk of Court, as the case may be, of the parish or parishes in which such person or persons conduct, transact or intend to conduct or transact such business, setting forth the name under which said business is, or is to be conducted or transacted and the true or real full name of the person or persons owning, conducting or transacting the same, with the post office address or addresses of said person or persons.

2.06 Rejection of Proposals Containing Alterations, Erasures or Irregularities:

Proposals may be rejected if they show an alteration of form, additions not called for, conditional or alternate bids, incomplete bids, erasures, or irregularities of any kind. If not accompanied by a proposal guaranty proposals shall be rejected.

2.07 Proposal Guaranty:

Each bid must be accompanied by a "Proposal Guaranty" equal to not less than 5 per cent of the correct total amount of the combination on which contract is awarded. Only certified checks will be accepted as the bidder's guaranty with his proposal; any deviations from this requirement will be considered cause for rejection of the bid. The certified check shall be issued by a State or National bank in good standing and shall be made payable to the Louisiana Department of Highways for not less than the amount specified above. Cashier's checks or currency will not be accepted as a substitute for certified checks. If cashier's check or currency is enclosed with the bid, the bid will be considered informal and, with the cashier's check and/or currency and all other enclosures, will be returned to the bidder without having been read.

2.08 Delivery of Proposals:

Each proposal shall be submitted, together with the proposal guaranty, in a special envelope furnished by the Department. The blank spaces on the envelope must be filled in correctly so as to clearly indicate its contents, and the envelope shall be sealed. If submitted by mail, the envelope shall be enclosed in another envelope addressed to the Department and should preferably be registered. If submitted otherwise than by mail, it shall be delivered to the proper place designated in the proposal. Proposals will be received up to the time stated and must be delivered to the Department at the designated place before the expiration of the time stipulated for the receipt of bids. Proposals received after the stipulated time will be returned to the bidder unopened.

2.09 Withdrawal of Proposals:

A bidder may, without prejudice to himself, withdraw a proposal after it has been deposited with the Department, provided the request for such withdrawal is received by the Department at the place designated in the proposal for the receipt of bids, in writing or by telegram, before the time set for opening proposals. The bidder may then submit a revised proposal provided it is received prior to the time set for opening proposals.

2.10 Public Opening of Proposals:

Proposals will be opened and read publicly at the time and place indicated in the "Notice to Contractors." Bidders or their authorized agents are invited to be present.

2.11 Disqualification of Bidders:

If more than one proposal is submitted by an individual, a firm or partnership, a corporation or association, under the same or different names, all proposals so submitted shall be considered irregular and shall be rejected. Reasonable ground for believing that any bidder is interested in more than one proposal for the work contemplated will cause the rejection of all proposals in which such bidder is interested. Any or all proposals will be rejected if there is any reason for believing that collusion exists among the bidders and all participants in such collusion will not be considered in future proposals for the same work. Unbalanced proposals may be rejected. No contract will be awarded except to responsible bidders capable of performing the class of work contemplated, and having sufficient equipment, financial resources and experience to properly perform the work.

2.12 Qualifications of Bidders:

Bidders must be capable of performing the various items of work bid upon. They will be required to furnish a statement covering experience in similar work, a list of machinery, plant organization and other equipment available for the proposed work, and such statements of their financial resources as may be deemed necessary, and shall be required to show that they have not failed to carry out all previous contracts with the Department. Each prospective bidder shall file with the Department, on forms fur-

nished by the Department, a financial and experience statement as of the date on which his fiscal year ends. Bidders may submit these statements either with their bid or prior to bidding.

In addition to the above, bidders shall submit a balance sheet showing their financial condition at the expiration of 6 months after the close of their fiscal year. The balance sheet shall be properly certified on forms furnished by the Department.

Financial statements previously filed with the Department shall remain in effect for a period not to exceed one year and 45 days after the close of the bidder's fiscal year and balance sheets shall remain in effect not to exceed 45 days after the close of the bidder's fiscal year.

All financial statements and balance sheet submitted to qualify for the performance of work in excess of $40,000.00 must be prepared and certified to by a Certified Public Accountant. In addition to the above requirements, the Department may require any bidder to file a financial and experience statement at any intermediate period.

Bidders will also be required to submit with their proposal a list of equipment proposed for use on each project in order that, in awarding the contract, it may be determined whether the equipment proposed for use on the project is adequate to complete the project within the time specified and in this respect determine the probable ability of the bidder to fulfill the contract.

Failure of the bidder to submit such a list may be cause for rejection of the bid. The acceptance or approval of the list of equipment by the Department or any of its employees will not operate to relieve the contractor of the responsibility of completing the project within the time limit.

The contractor must have all the equipment shown on the schedule available for immediate use.

2.13 Material Guaranty:

Before any contract is awarded, the 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 3

AWARD AND EXECUTION OF CONTRACT

3.01 Consideration of Bids:

For the purpose of award, the correct summation of the products of the approximate quantities shown in the proposal by their respective unit prices will be considered the amount of the bid. Until the final award of the contract is made, the right is reserved to reject any and all proposals and to waive technicalities when, in the opinion of the Chief Engineer, the best interest of the Department will be promoted thereby.

3.02 Award of Contract:

The award of the contract, if it be awarded, will be made only upon the recommendation of the Chief Engineer, to the lowest responsible bidder whose proposal shall comply with all the requirements necessary to render it formal. The award, if made, will be within 30 days after the opening of the proposals, but in no case will an award be made until all necessary investigations are made into the responsibility of the bidder to whom it is proposed to award the contract. The successful bidder will be notified, by letter mailed to the address shown on the proposal, that his bid has been accepted and that he has been awarded the contract. He shall execute the contract within 10 days after notice is issued.

3.03 Return of Proposal Guaranties:

All proposal guaranties, except that of the lowest responsible bidder, will be returned to the bidders immediately after the amounts of the bids have been determined, compared and the results of such comparisons have been considered by the Department. In no case will the proposal guaranties of other than the lowest responsible bidder be retained by the Department more than 15 days after the receipt of bids. The proposal guaranty of the lowest responsible bidder will be retained until the execution of the contract and approval of bond, after which it will be immediately returned.

Should no award be made within 30 days, all proposals will be rejected, and the proposal guaranty of the lowest

responsible bidder returned, unless additional time for consideration of the bid is requested by the Department and granted by the bidder.

3.04 Requirement of Contract Bond:

The successful bidder, at the time of the execution of the contract, must deposit with the Department the bond of a surety company acceptable to the Department and authorized to do business in Louisiana, in the amount of the total bid, conditioned that such work shall be performed in accordance with the plans, specifications and terms of the contract, and no surety company in which the bidder for the work is interested will be accepted as surety on the bond. Bond shall be given on the form provided by the Department.

3.05 Execution of Contract:

The successful bidder will be required to execute the contract and furnish bond satisfactory to the Department within 10 days after notice of award. In the case of a corporation, the officer or agent to execute the contract must be designated in a power of attorney executed by the Board of Directors, duly certified by the secretary and bearing the seal of the corporation. This power of attorney may be general, covering all contracts entered into with the Department until such time as it is revoked, or it may be specific authority for one contract. When the successful bidder is a partnership, a power of attorney designating one member of the firm to execute the contract shall be filed with the Department. This power of attorney must bear the signatures of all members of the firm and must be duly executed by a notary. Any officer or agent signing on behalf of the surety bonding the contractor will be required to file power of attorney with each bond executed and will be required to affix the seal of the surety to all bonds executed.

3.06 Failure to Execute Contract:

In the event of failure or refusal on the part of the bidder to whom the award is made to execute the contract and furnish satisfactory bond within 10 days after notice has been given the bidder by the Department of the award, the right is reserved by the Department to annul the award

and to award the contract to the next lowest bidder, or advertise for new proposals, or reject all bids. In the event the bidder to whom the award is made fails or refuses to execute the contract and furnish a satisfactory bond within the 10 days above specified, the "Proposal Guaranty" accompanying his bid shall become the property of the Department.

SECTION 4

SCOPE OF WORK

4.01 Intent of Plans and Specifications:

The intent is to prescribe a complete work or improvement which the contractor undertakes to do, in full compliance with the contract. The contractor shall perform all items of work covered and stipulated in the contract and perform extra work and shall furnish, unless otherwise definitely provided in the contract, all materials, implements, machinery, equipment, tools, supplies, transportation and labor necessary to the prosecution of the work.

4.02 Special Work:

Construction or conditions which have not been anticipated in these Standard Specifications will be covered by special provisions incorporated in, or attached to, the proposal form, which will be considered a part of the contract.

4.03 Increased or Decreased Quantities of Work:

The engineer may, without notice to the sureties on the contractor's bond, make such alterations in the quantities or in the nature of the work which he may consider necessary or desirable to complete fully the work as contemplated, provided such alterations do not change the original quantities of the contract items more than the limiting percentage of cost change set forth below. Such alteration shall not be considered as a waiver of any condition of the contract nor to invalidate any of the provisions thereof.

If the quantities of work specified in the contract are increased or decreased more than 25 per cent of the whole contract, measured in terms of the sum of the extension of quantities at the unit prices, a supplemental agreement to

the contract may be executed between the Department and the contractor, upon demand of either party, and when a supplemental agreement is executed, the consent of the contractor's surety to such supplement shall be obtained.

4.04 Extra Work:

Extra work shall be any work ordered by the engineer which is not covered by any item in the contract. Extra work shall be performed by the contractor under a "Supplemental Agreement," "Extra Work Order," or as "Force Account," and will be measured and paid for as specified in Article 9.04, Division I.

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

4.05 Traffic:

Handling Traffic: Satisfactory provision for local traffic must be made by the contractor, at his own expense, at all times during construction.

The plans and/or special provisions will state how through traffic shall be handled. When stated in the plans and/or special provisions, the contractor will be required to handle all traffic over the specified portion of the project at his own expense.

In the event that detours for through traffic are to be provided by the Department around the entire project or any major portion of the work during construction, the Department reserves the right, upon recommendation of the engineer, to open for use by traffic any uncompleted portions of the project. When specifically provided by the contract that traffic shall be routed over the project during construction, the contractor shall maintain the portion under traffic at his own expense. When not so provided, the Department may maintain such portions with its own forces or require the contractor to maintain them and reimburse him for such maintenance.

If the contractor hauls his materials or equipment over any road, culvert, or bridge provided by the State for the convenience of public travel, he shall so regulate his loads as not to exceed the capacity of the road and its structures as determined by the engineer. The contractor shall be re-

sponsible for any specific damage that may result to the road or its structures from failure to observe the above requirements.

When the road under construction is to be kept open for the use of the traveling public, special attention shall be paid to keeping both the subgrade and newly laid surfacing in such condition that the public can travel the road in safety. As soon as possible after rains, and at other times when directed, the contractor shall at his own expense machine the subgrade and drag and machine the newly laid surfacing material. The contractor shall be responsible for the convenience and safety of the traveling public.

On concrete pavement contracts, pavement will be opened to traffic as provided in the specifications for concrete pavement.

4.06 Rights In and Use of Materials Found on the Work:

The contractor, with the written approval of the engineer, may use in the proposed construction suitable stone, gravel, sand, or other material found in the "Excavation," which complies with the requirements of the specifications for the particular material and will be paid for the excavation of such materials at the contract unit price therefor, but he shall replace at his own expense with other suitable material all of that portion of the material so removed and used as was contemplated for use in the embankments, backfills, approaches, or otherwise. Except for the replacement herein provided, no charge for materials so used will be made against the contractor. Such material, suitable for special uses of the Department, when required by the engineer, shall be reserved and deposited in convenient places on the right of way or as directed, and no special allowance shall be made to the contractor for so reserving and storing such material. The contractor shall not excavate or remove any material from within the highway right of way which is not within the excavation, as indicated by the slope and grade lines, without written authorization from the engineer.

4.07 Final Clearing Up:

Upon completion of the work and before acceptance and final payment is made, the contractor shall clean and remove from the roadway, footways and adjacent property all surplus and discarded materials, weeds, bushes, rubbish,

temporary structures and equipment, and shall leave the entire right of way in such condition that it can be properly mowed. He shall restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work, and shall leave the site of the work in a neat and presentable condition throughout.

Upon completion of any structure, all superfluous material, cofferdams unless otherwise ordered, construction buildings and other temporary structures and debris resulting from construction shall be removed. Falsework, timbers and piles are to be removed to the ground level. Upon completion of work in connection with drainage structures, the contractor will be required to remove all debris, such as drift, weeds, dirt, scraps of building material, or any other obstructions to the flow of water, from inside all culverts whether new or old.

All materials shall be deposited on the downstream side of the roadway, or otherwise disposed of as directed by the engineer, and stream channels, structures and roadway left in a neat and presentable condition.

No special payment will be made for this work, its cost being included in the price paid for the construction work.

SECTION 5

CONTROL OF WORK

5.01 Authority of Engineer:

The work shall be done under the direct supervision of the engineer and to his satisfaction. The engineer shall decide any and all questions which arise as to the quality or acceptability of materials furnished and work performed, manner of performance, rate of progress of work, interpretation of the plans and specifications, all questions as to the acceptable fulfillment of the contract on the part of the contractor, disputes and mutual rights between contractors under these specifications, and as to compensation. His decisions shall be final and he shall have executive authority to enforce and make effective such decisions and orders as the contractor fails to carry out promptly. In case of failure on the part of the contractor to execute work ordered by the engineer, the engineer may, at the expiration of a period

of 48 hours after giving notice in writing to the contractor, proceed to execute such work as may be deemed necessary. In the event of an emergency, the 48 hour period may be waived, and the work performed immediately. The cost of this work shall be deducted from compensation due or which may become due the contractor under the contract.

5.02 Plans and Working Drawings:

The Department will furnish the contractor without charge 2 sets of plans and upon written request by the contractor additional sets of plans will be supplied without charge to a maximum of 5 sets.

The plans will consist of general drawings, showing such details as are necessary to give a comprehensive idea of the construction contemplated.

Roadway plans will show alignment, profile, typical cross sections of improvements, and general cross sections.

Structure plans will, in general, show in detail all dimensions of the work contemplated. When the structure plans do not show all dimensions in detail, they will show general features and such details as are necessary to give a comprehensive idea of the structure.

The contractor shall submit to the engineer for approval 3 sets of any required preliminary detailed shop or working drawings. These plans shall be submitted in sufficient time to allow discussion and correction prior to beginning the work they cover and any delay in the work occasioned by the nonapproval of the plans shall not be cause for an extension in contract time. Prior to the approval of these drawings any work done or materials ordered for the structures involved shall be at the contractor's risk. One set of these drawings shall be returned to the contractor approved or marked with corrections to be made; the other sets will be retained by the Department.

Working drawings for steel structures shall consist of shop detail, erection, and other working plans showing details, dimensions, sizes of material and other information necessary for the complete fabrication and erection of the metal work.

Working drawings for concrete structures shall consist of such detailed plans as may reasonably be required for the successful prosecution of the work and which are not

included in the plans furnished by the Department. These may include plans for falsework, bracing, centering and form work, masonry layout diagrams and diagrams for bent reinforcement.

It is expressly understood that the approval of the engineer of the contractor's working drawings is general only, and such approval will not relieve the contractor from any responsibility whatsoever.

Upon final approval of all working drawings, the contractor shall submit to the engineer such copies of the approved, corrected, detailed drawings as may be required in the specifications or special provisions covering specific items of the contract, and upon completion of the work, the original corrected tracings shall be surrendered to the Department.

The contract price shall include the cost of furnishing all working drawings and the contractor will be allowed no extra compensation for such drawings.

5.03 Conformity with Plans and Allowable Deviations:

The location, details and dimensions of the finished work must conform strictly to the approved plans. Any deviation from the plans as may be required, in all cases, will be determined by the engineer and authorized in writing.

5.04 Coordination of Plans, Specifications and Special Provisions:

These specifications, the accompanying plans, special provisions and all supplementary documents are essential parts of the contract. They are intended to be complementary, to describe and provide for a complete work and a requirement occurring in one is as binding as though occurring in all. In case of a discrepancy, figured dimensions, unless obviously incorrect, shall govern over scaled dimensions, plans shall govern over specifications, and special provisions shall govern over both specifications and plans. The contractor shall take no advantage of any error or omission of dimensions in the plans, or of any discrepancy between the plans and specifications. The engineer will make such corrections and supply such omitted dimensions as may be necessary, and his interpretation shall be final.

5.05 Cooperation by Contractor:

The contractor shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the engineer in every way possible. He shall have available on the work at all times one complete copy of the contract, including plans, specifications, special provisions and authorized alterations supplied to the contractor. He shall have at all times a competent and reliable English speaking superintendent on the work authorized to receive orders and to act for him. The superintendent shall be designated, in writing to the engineer, by the contractor, and shall be qualified to superintend the performance of the particular type of work to be performed. Such superintendent shall be furnished by the contractor regardless of how much work may be sublet. The contractor must at all times maintain a representative within the bounds of the State who shall be designated to the Department to accept service and citation.

In the event the performance of work under this contract, is carried on simultaneously with the construction work being performed by other contractors on adjacent or adjoining work, the contractor shall arrange his work so as not to interfere with the operation of other contractors engaged upon said adjacent or adjoining work and shall join his work in the proper sequence in relation to that of other contractors, all as may be directed by the engineer. Each contractor shall be held responsible for any damage done by him, his agents or subcontractors to the work performed by another contractor, and shall bear the cost of all such damages done by his employees, agents or subcontractors. The Department will not entertain any claims for damages or delays resulting from such operation, and will not be responsible for any delay caused by disagreement or lack of cooperation between contractors.

5.06 Construction Stakes, Lines and Grades:

The engineer will set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and center line and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he may deem 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 govern and execute the work.

The contractor shall furnish, free of charge, all additional stakes, all templets and other material necessary for making and maintaining points and lines given and shall furnish the engineer with such labor as he may require in establishing points and lines essential to the prosecution of the work.

The contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them shall be charged against him, and shall be deducted from the payment for the work.

5.07 Authority and Duties of Project Engineer:

The project engineer shall be in direct charge of the work and shall have full authority, under the engineer, in directing the proper performance thereof. He shall set such stakes as may be required for the proper direction of the contractor in establishing lines, grades or other details indicated by the plans. He may also direct the sequence of the work, establish the priority of the several construction features, make or have made the necessary tests of all materials used in the work, compile the data required in computing the estimates of the work actually done, and shall perform such other duties as may be assigned to him. In no case shall he act as an assistant to the contractor, as a foreman or in any similar capacity. In case of any dispute arising between the contractor and the project engineer as to materials furnished or the manner of performing the work, the project engineer shall have the authority to reject materials, or suspend the work until the question at issue can be referred to and decided by the engineer. He shall not be authorized to revoke, alter, enlarge, relax or release any requirements of these specifications, or to approve or accept any portion of work, or to issue instructions contrary to the plans and specifications. Any personal advice which the project engineer may give the contractor shall in no wise be construed as binding the engineer or the Department in any way or as releasing the contractor from the fulfillment of the terms of the contract.

5.08 Authority and Duties of Inspectors:

Inspectors employed by the Department shall be authorized to inspect all work done and all material furnished. Such inspection may extend to all or any part of the work and to the preparation or manufacture of the materials to be used. An inspector shall be stationed on the construction to report to the engineer as to the progress of the work and the manner in which it is being performed; also to report whenever it appears that the materials furnished and the work performed by the contractor fail to fulfill the requirements of the contract, and to call to the attention of the contractor any such failure or other infringement; but such inspection shall not relieve the contractor from any obligation to perform all of the work in accordance with the requirements of the contract. In case of any dispute arising between the contractor and the inspector as to materials furnished or the manner of performing the work, the inspector shall have the authority to reject materials or suspend the work until the question at issue can be referred to the project engineer. The inspector shall not, however, be authorized to revoke, alter, enlarge, relax or release any requirements of the contract, nor to approve or accept any portion of the work, nor to issue instructions contrary to the plans and specifications. He shall in no case act as foreman or perform other duties for the contractor, nor interfere with the management of the work. Any personal advice which the inspector may give the contractor shall in no wise be construed as binding the engineer or the Department in any way, or as releasing the contractor from the fulfillment of the terms of the contract.

5.09 Inspection:

The engineer and his inspectors shall have free access to all parts of the work, and to all materials intended for use in the work. The contractor shall furnish the engineer with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements and intent of the specifications and the contract. The work will be inspected as it progresses, but failure to reject or condemn defective work or materials at the time it is done will in no way prevent its rejection whenever it is discovered. If the engineer requests it, the contractor shall, at any time before the acceptance of the work, re-

move or uncover such portions of the finished work as may be directed. After examination, the contractor shall restore said portions of the work to the standard required specifications. Should the work thus exposed or examined prove acceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed, shall be paid for as "Extra Work" but should the work so exposed or examined prove unacceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed, shall be at the contractor's expense. No work shall be done, nor materials used, without suitable supervision or inspection by the engineer or his representative.

When the United States Government, or other state department or governmental agency, or any railroad corporation, or any other agency, is to pay a portion of the cost of the work covered by this contract, their respective representatives shall have the right to inspect the work.

5.10 Defective and Unauthorized Work:

All work which has been rejected shall be remedied or removed, if necessary, and replaced in an acceptable manner by the contractor at his own expense, and no compensation shall be allowed him for such removal or replacement. Work done without lines or grades being given or beyond the lines and grades shown on the plans, except as herein provided, or any extra work done without written authority will be considered as unauthorized and at the expense of the contractor, and will not be measured or paid for. Work so done may be ordered removed at the contractor's expense. Upon failure on the part of the contractor to forthwith comply with any order of the engineer made under the provisions of this article, the engineer shall have authority to cause defective work to be remedied, or removed and replaced, and unauthorized work to be removed and such costs to be deducted from any monies due or to become due the contractor; or the engineer, if he so elects, may withhold any money due or becoming due the contractor until such time as the work is satisfactorily corrected.

5.11 Final Inspection:

Whenever the work provided for and contemplated by the contract shall have been satisfactory completed and

the final cleaning up performed, the project engineer shall notify the engineer in writing that said work is completed and ready for final inspection. The engineer shall, unless otherwise provided, make the final inspection within a reasonable length of time after the receipt of such notification.

SECTION 6

CONTROL OF MATERIALS

6.01 Source of Supply and Quality of Materials:

The source of supply of each of the materials shall be approved by the engineer before the delivery is started. Representative preliminary samples of the character and quantity prescribed shall be submitted by the contractor or producer for examination and tested in accordance with the methods referred to under tests of samples of materials. Only materials tested and found to conform to the requirements of these specifications and approved by the engineer shall be used in the work. All materials proposed to be used may be inspected or tested at any time during their preparation and use. If, after trial, it is found that sources of supply which have been approved do not furnish a uniform product, or if the product from any source proves unacceptable at any time, the contractor shall furnish approved material from other approved sources. No material which, after approval, has in any way become unfit for use shall be used in the work. Stored material, even though approved before being stored, shall be inspected prior to use in the work and shall meet the requirements of the specifications at the time of its use.

6.02 Plant Inspection:

If the volume of the work, construction progress, and other considerations warrant, the engineer may undertake the inspection of materials at the source, but it is understood that no obligation is assumed to inspect materials in this manner. Plant inspection will be undertaken solely as a matter of convenience to the contractor and producers and only upon condition that:

The cooperation and assistance of the contractor and the producer with whom he has contracted for materials is assured.

The representative of the engineer shall have free entry at all times to such parts of the plant as may concern the manufacture or production of the materials ordered.

When required by the engineer, the material producer shall furnish an approved weatherproof building for the use of the inspector, such building to be located conveniently near the plant and independent of any building used by the material producer.

It is understood that the engineer reserves the right to retest all materials 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 these specifications.

6.03 Samples and Tests:

The contractor shall give sufficient notification of the placing of orders for materials to permit testing; shall afford such facilities as the engineer may require for collecting and forwarding samples; shall not make use of or incorporate in the work the materials represented by the samples until tests have been made and the materials found to be in accordance with the requirements of the specifications; and shall furnish without charge all samples required.

When required by the engineer, representative preliminary samples of the character and quantity prescribed shall be submitted by the contractor or producer for examination and shall be tested in accordance with the methods referred to herein. The acceptance of a preliminary sample, however, shall not be construed as acceptance of materials from the same source delivered later. Only the materials actually delivered for the work will be considered and their acceptance or rejection will be based solely on the results of the tests prescribed in these specifications.

For the verification of weights or proportions and character of materials, and determinations of temperatures used in the preparation of the materials and mixtures, the engineer shall have access at all times to all parts of any plants connected with the work. The contractor shall facilitate and assist the verification of all scales, measures and other devices which he operates.

Unless otherwise specifically provided, all sampling and testing and laboratory methods required under this contract shall be in accordance with the latest revision of the A.S.T.M.

Standards, as amended to date of contract, and when not covered therein shall be sampled and tested in accordance with the Standard Specifications for Highway Materials and Methods of Sampling and Testing of the A.A.S.H.O., with subsequent revisions to date of contract. All tests not covered by the above shall be performed as specified by the engineer.

6.04 Storage of Materials:

Materials shall be stored so as to insure the preservation of their quality and fitness for the work, and in a manner that leaves the material accessible to inspectors. With the approval of the engineer, material may be stored on the right of way provided such storage does not interfere with the prosecution of the work or with public travel.

6.05 Defective Materials:

All materials not conforming to the requirements of these specifications shall be considered as defective, and all such materials whether in place or not, shall be rejected and shall be removed immediately from the site of the work, unless otherwise permitted by the engineer. No rejected material, the defects of which have been subsequently corrected, shall be used until approval has been given. Upon failure on the part of the contractor to forthwith comply with any order of the engineer made under the provisions of this article, the engineer shall have authority to remove and replace defective material and to deduct the cost of removal and replacement from any monies due or to become due the contractor.

6.06 Materials Furnished by the Contractor:

Unless otherwise specifically stated in the contract, all materials needed in the work will be furnished by the contractor. The contractor will assume full responsibility in ordering materials of the quality specified in the specifications. The contractor will be responsible for the payment of all materials ordered by him in accordance with the contract, and this shall include payment of all freight and demurrage charges incurred in the shipment. The contractor will be responsible for the proper storage and handling of the material to insure the required quality before and during incorporation into the work.

6.07 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 to compensate for increases and decreases 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 or decrease 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.

SECTION 7

LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

7.01 Laws to be Observed:

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

7.02 Permits and Licenses:

The contractor shall procure all permits and licenses, pay all charges and fees, and give all notices incident to the due and lawful prosecution of the work.

7.03 Patented Devices, Materials and Processes:

If the contractor is required or desires to use any design, device, material, or process covered by letters, patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner, and a copy of this agreement shall be filed with the Department. The contractor and the surety shall indemnify and save harmless the Department from any and all suits, costs, penalties, or claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright in connection with the work agreed to be performed under this contract, and shall indemnify and save harmless the Department for any costs, expenses and damages which it may be obliged to pay by reason of any such infringement or alleged infringement at any time during the prosecution or after the completion of the work.

7.04 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 hereby 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.

Any individual or corporation wishing to make an opening in the highway must secure a permit from the Department and the contractor shall not allow any person to make an opening unless a duly authorized permit of the Department is presented. Upon the presentation of a duly authorized and satisfactory permit, the contractor may allow parties bearing such permits to make openings in the highway. The contractor shall, if ordered by the engineer in writing, make in an acceptable manner all necessary repairs due to such openings; and such necessary work ordered by the engineer shall be paid for on the basis of extra work or force account as provided for in these specifications.

7.05 Federal Participation:

When the United States Government pays all or any portion of the cost of a project, the work shall be subject to the inspection of the appropriate Federal agency.

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 hereunder.

7.06 Sanitary Provisions:

The contractor shall observe all rules and regulations of the State Board of Health, or any bodies having jurisdiction, and of all local health officials, and must take such precautions as are necessary to avoid unhealthful conditions.

7.07 Public Convenience and Safety:

The contractor shall at all times so conduct his work as to insure the least practicable obstruction to traffic. The convenience of the general public, the residents along and adjacent to the highway, and the protection of persons and property are of prime importance and shall be adequately provided for by the contractor. Fire hydrants on or adjacent to the highway shall be kept accessible to the fire apparatus at all times and no material or obstructions shall be placed within 10 feet of any such hydrant. Materials stored upon the highway shall be placed so as to cause no unnecessary obstruction to the traveling public. No section of road shall be closed to the public except by express permission of the engineer, which permission may be revoked by the engineer at any time. When the highway under construction is open to the traveling public, the contractor shall maintain both the subgrade and the surfacing in such condition that the public can travel over the same in comfort and safety and shall at his own expense blade and drag the subgrade and all courses adapted to such treatment, when and as directed by the engineer. To accommodate traffic on the roadway under construction, the contractor shall provide and maintain in a passable condition all necessary by-passes around structures or suitable and adequate temporary bridges over the structures to be rebuilt or extended. If the maintenance of traffic over detours for which the contractor is responsible makes necessary the construction of bridges or temporary stream crossings, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings. During the progress of the work, the contractor shall provide for local traffic to private property within the closed portion of the work. The contractor shall provide and maintain in a safe con-

dition temporary approaches to, and crossings of, railways and intersecting highways. When so provided in the contract or directed by the engineer, concrete base courses, concrete pavements, and other pavements shall be constructed one-half width at a time, opened to traffic in accordance with the contract and satisfactorily maintained. Unless specifically otherwise provided for by the plans and/or special provisions, the cost of all necessary materials and all other costs incidental to the public's convenience and safety shall be borne by the contractor and shall be included by him in his bid prices for the various pay items appearing in the proposal and contract. The contractor shall cooperate with the engineer in the regulation of traffic. If, in the opinion of the engineer, the above requirements are not complied with, the engineer may have such work done as he considers necessary and charge the cost to the contractor. The contractor will not be responsible for the maintenance of traffic on independent detours provided by the Department.

7.08 Barricades, Danager, Warning and Detour Signs:

The contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient red lights, danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and workmen and safety of the public. Highways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. The contractor shall provide and maintain warning and detour signs at all closures, intersections and along the detour routes, directing the traffic around the closed portion or portions of the highway, so that the temporary detour route or routes shall be indicated clearly throughout its or their entire length. Such warning and detour signs shall conform to the Louisiana Manual on Uniform Traffic Control Devices. All barricades and obstructions shall be illuminated at night and all lights shall be kept burning from sunset until sunrise. As a precaution against failure of lights, all barricades placed by the contractor shall be equipped with reflector buttons, discs, scotchlite or other suitable light reflecting material satisfactory to the engineer. The contractor will be held responsible for all damage to the project due to failure of the signs and/or barricades to

properly protect the work from traffic, pedestrians, animals, and from all other sources, and whenever evidence of any such traffic is found upon the unaccepted work, the engineer will order that the work, if in his opinion it is damaged, be immediately removed and replaced by the contractor without cost to the Department. The contractor's responsibility for the maintenance of barricades, signs, and lights shall not cease until the project shall have been completed and accepted.

7.09 Use of Explosives:

When the use of explosives is necessary for the prosecution of the work, the contractor shall use the utmost care not to endanger life or property. Only light shooting will be permitted without specific authority of the engineer, and whenever directed, the number and size of the charges shall be reduced. All explosives shall be stored in a secure manner and all such storage places shall be marked clearly "DANGEROUS—EXPLOSIVES." The method of hauling, storing and handling explosives and highly inflammable materials shall conform to Federal and State laws and regulations.

7.10 Preservation and Restoration of Property, Trees, Monuments, Etc.:

The contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the roadway and shall use every precaution necessary to prevent damage or injury thereto. He shall use suitable precaution necessary to prevent damage to pipes, conduits, and other underground structures, and shall protect carefully from disturbance or damage all land monuments, State and United States bench marks, geodetic and geological survey monuments, and property marks until the engineer has witnessed or otherwise referenced their location and shall not remove them until directed.

Where U. S. Government bench marks, Louisiana Geodetic Survey bench marks and other monuments fall within the limits of construction, the contractor will be required to remove and reset same in new locations as hereinafter provided.

Before removing and resetting government bench marks, the contractor shall give sufficient advance notice to the appropriate governmental agency of his intention to perform the work in order that the proper authority of such agency may have a representative present if he so desires.

Before removing and resetting Louisiana Geodetic Survey bench marks or other monuments, the contractor shall give sufficient advance notice to the project engineer of his intention to perform the work.

The project engineer shall designate the location and the manner in which bench marks or other monuments are to be reset. No direct payment will be made for removing and resetting bench marks or other monuments but all cost incidental thereto shall be included in the unit prices on the various pay items included in the contract.

Any utility lines damaged by the contractor shall be repaired at once at his own expense in accordance with the requirements of Article 8.04, Division I. The contractor shall not injure or destroy trees or shrubs nor remove or cut them without proper authority. The contractor shall be responsible for any damage done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work or on account of defective work or material. 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 same, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the contractor to restore such property or make good such damages or injury, the engineer may, after 48 hours written notice, proceed to repair, rebuild, or otherwise restore such propety as may be deemed necessary and the cost thereof will be deducted from any monies due or which may become due the contractor under this contract. In case no money is due or to become due, his surety shall be held until such time as all suits, claims, or damages shall have been settled and suitable evidence to that effect furnished the engineer.

7.11 Forest Protection:

In carrying out work within or adjacent to State or National Forests, the contractor shall comply with all of the regulations of the State Fire Marshal, Conservation De-

partment, Forest Commission and U. S. Forest Service, 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 and to extinguish same if near by and practicable.

7.12 Responsibility for Damage Claims:

The contractor shall indemnify and save harmless 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, persons, 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 act or omission, neglect, or misconduct of said contractor; or because of any claims or amounts recovered from any infringement of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, bylaw, ordinance, order or decree.

The contractor shall carry at his expense Workman's Compensation Insurance as, and to the extent, provided by law. Within 2 weeks after the contractor has signed the contract, he shall furnish satisfactory evidence of said insurance coverage to the Department. Satisfactory evidence of coverage shall consist of a certificate from the insurance company covering each Workman's Compensation Insurance Policy carried by the contractor and/or subcontractors.

The contractor shall not be released from said responsibility until the contract shall have been completed and the work accepted, and so much of the money due the said contractor under and by virtue of his contract as shall 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 shall 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.

7.13 Opening of Section of Highway to Traffic:

The contractor will be required to maintain the highway in first class condition until final acceptance. Whenever, in the opinion of the engineer, any roadway, or portion thereof, is in acceptable condition for travel, it shall be opened to traffic as may be directed and such opening shall not be held to be in any way an acceptance of the roadway or any part of it, or as a waiver of any of the provisions of these specifications and contract. Necessary repairs or renewals made on any section of the roadway, due to its being opened to travel under instructions from the engineer, to defective materials or work, to natural causes, to ordinary wear and tear or otherwise, pending completion and acceptance of the roadway, shall be performed at the expense of the contractor. The contractor shall harrow, drag or otherwise maintain the completed sections of the roadway until final acceptance of such sections, in a manner approved by the engineer.

7.14 Contractor's Responsibility for Work:

Until the acceptance of the work by the engineer as evidenced in writing, it shall be under the charge and care of the contractor. He shall take every necessary precaution against damages to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The contractor shall rebuild, restore, repair, and make good, at his own expense, all injuries or damages to any portion of

the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to acts of God, of the public enemy or of governmental authorities.

No work under this contract will be accepted in sections unless specifically provided for by the plans and/or special provisions and in no case will the retained percentage amount be paid the contractor until completion and acceptance of the entire project.

In case of the suspension of work from any cause whatever, the contractor shall be responsible for all materials, shall properly store them if necessary and shall provide suitable drainage of the roadway and erect temporary structures where necessary. When the final inspection has been made as provided in Article 5.11, Division I, and the work accepted in writing by the Chief Engineer, the contractor will be relieved of any construction responsibility subject to the provisions of Articles 7.12, 8.10 and 9.06, Division I.

7.15 Personal Liability of Public Officials:

In carrying out any of the provisions contained hereinbefore or in exercising any power or authority granted to him by this contract, there shall be no liability upon the Chief Engineer or his authorized assistants, either personally or as an official of the State, it being understood that in such matters he acts as the representative of the State.

7.16 No Waiver of Legal Rights:

Inspection by the engineer or by any of his duly authorized representatives; any order, measurement or certificate by the engineer; any order by the Department for the payment of money; any payment for or acceptance of any work or any extension of time; or any possession taken by the Department shall not operate as a waiver of any provision of the contract, or any power therein preserved to the Department, or of any right to damages therein provided. Any waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

The Department reserves the right to correct any error that may be discovered in any estimate that may have been paid, and to adjust the same to meet the requirements of the contract and specifications. Upon conclusive proof of

collusion or dishonesty between the contractor or his agents and the engineer or his assistants being discovered in the work after final payment has been made, the Department reserves the right to claim and recover by process of law, sums as may be sufficient to correct the error or make good the defects in the work resulting from such error, dishonesty or collusion.

7.17 Furnishing Right of Way:

All necessary right of way for the proper completion of the work will be secured by the Department without cost to the contractor, unless otherwise specifically provided.

SECTION 8

PROSECUTION AND PROGRESS OF WORK

8.01 Subletting or Assigning of Contracts:

The contractor shall not assign, sell, transfer or otherwise dispose of the contract, or his rights, title or interest therein, without previous written approval of the Chief Engineer. In case such consent is given, the contractor will be permitted to sublet a portion thereof, but, shall perform with his own organization work amounting to not less than 50 per cent of the remainder obtained by subtracting from the original contract value the sum of any items designated in the contract as "Specialty Items."

Any items that have been selected as "Specialty Items" for the contract will be listed in the contract special provisions.

Delivery of materials may be sublet without the written approval of the project engineer.

No subcontract will in any case relieve the contractor of his responsibility under the contract and bond.

8.02 Prosecution of Work:

The contractor shall begin the work to be performed under the contract within 10 calendar days after the date of the work order. The contract days shall start 10 calendar days after the date of the work order.

The contractor shall start construction operations on that part of the project designated by the engineer, or set

forth in the "Progress Schedule," and the work shall be conducted in such manner and with sufficient materials, equipment, and labor as are considered necessary to insure its completion in accordance with the plans and specifications as interpreted by the engineer, within the time set forth in the proposal. Should the prosecution of the work for any reason be discontinued, the contractor shall notify the engineer at least 24 hours in advance of resuming operations.

8.03 Limitations of Operations:

The contractor shall at all times conduct the work in such manner and in such sequence as will insure the least practicable interference with traffic and he shall have due regard to convenient detours. He shall not open up work to the prejudice of work already started and this feature of the prosecution of the work shall be governed by the order of the engineer.

8.04 Cooperation with Public Utilities:

It shall be the contractor's responsibility to notify all public utilities or other parties interested to make all necessary adjustments of public utility fixtures and appurtenances within or adjacent to the limits of construction. Unless otherwise specified, these adjustments are to be made by the owners.

The contractor will be responsible for any damage done by him to any telephone, telegraph, power poles or lines, water or fire hydrants, water mains and pipe lines, sewers, conduits and other accessories and appurtenances of a similar nature which are fixed or controlled by a city, public utility company or corporation. He shall perform and carry on his work in such a manner as not to interfere with or damage fixtures mentioned herein, or as shown on the plans, or discovered during construction, which are to be left within the limits of the project. The Department will not be responsible for any delay or damage incurred by the contractor due to working around or joining his work to fixtures left in place.

In the event of interruption to water or 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. He shall cooperate with the said authority in the restoration of service as promptly as pos-

sible. In no case shall interruption to water srevice be allowed to exist outside of working hours.

The Department will not be responsible for any delays or inconvenience to the contractor in carrying on his work in the above mentioned manner and/or while the public utility companies or city are making necessary adjustments of their fixtures or appurtenances. Any additional cost incurred shall be the expense of the contractor, and shall be considered as completely covered by the contract unit prices for the various pay items provided for in the proposal and contract.

8.05 Character of Workmen and Equipment:

The contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time specified. Failure by the contractor to provide adequate equipment or labor may result in the annulment of the contract as hereinafter provided. Any foreman or workman employed by the contractor or by any subcontractor who, in the opinion of the engineer or his authorized representative, disobeys orders, does not perform his work in a proper and skillful manner, or is disrespectful, intemperate, disorderly, or otherwise objectionable, shall at the written request of the engineer be forthwith discharged by the contractor, or subcontractor, employing such foreman or workman, and shall not be employed again on any portion of the work without the written consent of the engineer. Should the contractor fail to remove such person or persons, or fail to furnish suitable and sufficient machinery, equipment or force for the proper prosecution of the work, the engineer may withhold all estimates which are or may become due, or may suspend the work until such orders are complied with.

All workmen must have sufficient skill and experience to properly perform the work assigned them. All workmen engaged on special work or skilled work, such as bituminous courses or mixtures, concrete base courses, pavements or structures, or in any trade, shall have had sufficient experience in such work to properly and satisfactorily perform it and operate the equipment involved, and shall make due and proper effort to execute the work in the manner prescribed in these specifications. Otherwise the engineer may take action as above prescribed.

All machinery and equipment owned or controlled by the contractor, which is proposed to be employed by him on the work, shall be of sufficient size to meet the requirements of the work and shall be such as to produce a satisfactory quality of work; all to be subject to the inspection and approval of the engineer. No change in machinery and equipment employed on the work, which shall have the effect of decreasing its capacity shall be made except by written permission of the engineer. The measure of the capacity shall be its actual performance on the work. No item of equipment or machinery, after once being placed on the work, shall be removed without the consent of the engineer.

8.06 Temporary Suspension of Work:

The engineer shall have the authority to suspend the work wholly or in part. The order to suspend the work for periods exceeding one calendar day shall be in writing and shall include the specific reasons for the suspension.

If the work is suspended by the engineer in the interest of the Department due allowances shall be made for the time elapsed during the period of suspension as hereinafter provided.

If the work is suspended by the engineer because of the failure or refusal of the contractor to comply with the order of the engineer or with the plans and specifications the time elapsed during such suspension shall remain charged against the contractor.

When the work is suspended, the contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way; take every precaution to prevent damage or deterioration of the work performed; provide suitable drainage of the roadway by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the engineer. Liquidated damages shall not accrue during the period in which work is suspended by approval of the engineer unless suspension is due to the failure of the contractor to perform any of the provisions of the contract.

8.07 Progress Schedule:

The contractor shall submit, prior to the award of the contract, a progress schedule satisfactory to the engineer, showing the proposed order of work and indicating the time required for the completion of the major items of work. This working schedule shall be used as the basis for establishing major construction operations and as a check on the progress of the work.

8.08 Determination and Extension of Contract Time:

The time within which the work is required to be completed is of the essence of this contract. The contract time shall consist of the contract days elapsed during the period beginning 10 days after the date of the work order as provided in Article 8.02, Division I, and ending with the Chief Engineer's acceptance of the work as provided in Article 8.11, Division I. The number of contract days which shall be counted for each month shall be as follows:

January	12 days	July	18 days
February	12 days	August	18 days
March	12 days	September	20 days
April	18 days	October	20 days
May	18 days	November	18 days
June	18 days	December	18 days

The number of contract days for less than a calendar month shall be proportionate to the nearest integer.

The contract time shall automatically be extended by a period proportional to the positive difference in dollars obtained by subtracting the amount of the contract from the total amount of the final estimate.

The contract time shall automatically be extended by the period during which the whole work, or a controlling part thereof, was suspended by the engineer in the interest of the Department as provided in Article 8.06, Division I.

At any time before the payment of the final estimate, the contractor may submit to the engineer an application for an extension of the contract time. In support of the application the contractor shall allege delay in the performance of the work only by either or both of the following causes:

(a) An act of the State.

(b) "Fortuitous events" or "events beyond the control" as defined in Louisiana jurisprudence.

This application must show in detail the cause of delay, the terminal dates influenced by the causes recited and

clearly indicate how the progress of the work as a whole was retarded. The application must be accompanied by ample evidence which can be verified by the engineer.

The engineer shall promptly make a written report and recommendation on the protest or application presented by the contractor and forward it to the Chief Engineer. The documents shall be reviewed by the Chief Engineer and the contractor notified of the decision reached. If an extension of time is approved, the contractor shall secure the assent of his surety thereto.

8.09 Failure to Complete Work on Time:

Should the contractor fail to complete the work in the time specified in the contract, or within such extra time as may have been allowed for delays by formal extensions, a deduction of an amount equal to the actual cost incurred by the Department will be made for each and every calendar day that such contract remains uncompleted after the time above designated for the completion. The said amount is hereby agreed upon as liquidated damages for the loss to the Department on account of the expenses due to the employment of engineers, inspectors and other employees and the maintenance of any detours which are required to maintain traffic after the expiration of the number of contract days agreed upon, and 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. Permitting the contractor to continue and finish the work or any part of it after the time affixed for its completion, or after the date to which the time of completion may have been extended, shall in no way operate as a waiver on the part of the Department of any of its rights under this contract.

8.10 Default of Contract:

If the contractor fails to begin the work within the time specified; or if the construction or work to be done under this contract shall be abandoned; or if this contract, or any part thereof, shall be sublet without the previous written consent of the Chief Engineer; or if the contract shall be assigned by the contractor otherwise than as herein specified; or if at any time the engineer shall be of the opinion that the work or any part thereof is unnecessarily

or unreasonably delayed or that the contractor has violated any provision of this contract; or if the contractor shall discontinue the prosecution of the work without authority; or shall become insolvent or be declared bankrupt, or shall commit any act of bankruptcy or insolvency; the engineer may give notice in writing to the contractor and his surety of such delay, neglect, or default, specifying the same. If the contractor within a period of 10 days after such notice shall not proceed in accordance therewith, then the party of the first part shall, upon written certificate from the engineer 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 contractor and to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable, and enter into an agreement for the completion of the contract according to the terms and provisions thereof or use such other methods as in his opinion may be required for the completion of the contract in an acceptable manner.

All costs and charges that may be incurred under this article, or any damages that should be borne by the contractor, shall be withheld or deducted from any monies then due, or to become due the contractor, under this contract, or any part thereof; and in such accounting the Department shall not be held to obtain the lowest cost of the work of completing the contract or any part thereof, but all sums actually paid therefor shall be charged to the contractor. In case the costs and charges incurred are less than the sum which would have been payable under the contract, if the same had been completed by the contractor, the contractor or his surety shall be entitled to receive the difference and in case such costs and charges exceed the said sum, the contractor or his surety shall pay the amount of excess to the Department for the completion of the work.

8.11 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 Article 7.16, Division I.

SECTION 9

MEASUREMENT AND PAYMENT

9.01 Measurement of Quantities:

The measurements necessary to determine the quantities of work actually performed under this contract will be taken by the engineer. The units used, unless otherwise specified, shall be United States Standard.

Earthwork will be computed by the average end area method, using lengths measured on the center line as the distance between cross sections.

The prismoidal formula will be used in computing the volume of masonry.

All longitudinal measurements for area will be made along the actual surface of the roadway and not horizontally.

For all transverse measurements for area of base courses, surface courses and pavements, the dimensions to be used in calculating the pay area shall be the net dimensions shown on the plans or ordered in writing by the engineer.

No deductions will be made for fixtures in the roadway having an area of 9 square feet or less.

All materials which are specified for measurement by the cubic yard in vehicles shall be hauled in approved vehicles and measured therein at the point of delivery. Allowance will not be made for wastage or shrinkage of material during its transportation from the pit, barge, car, or other point of loading to the unloading point. The contractor shall strike off and level the load, and the checker or inspector shall inspect each load and check its yardage. Approved vehicles for this purpose may be of any size or type acceptable to the engineer provided the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specific approved capacity. The inspector may reject all loads not hauled in approved vehicles.

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

9.02 Scope of Payment:

The contractor shall receive and accept the compensation provided for in the contract as full payment for furnishing all materials, labor, tools and equipment, and for performing all work contemplated and embraced under the contract, in a complete and acceptable manner in accordance with the contract; for all loss or damage arising out of the nature of the work or from the action of the elements; for all expense incurred by, or in consequence of, the suspension or discontinuance of the said prosecution of the work as herein specified, or from any unforseen difficulties or obstructions which may arise or be encountered during the prosecution of the work; and for all risks of every description connected with the prosecution of the work until its final acceptance by the Chief Engineer. The payment of any current or final estimate or the acceptance of any portion of the work as provided in the contract shall in no way or in no degree affect the obligation of the contractor, who, at his own cost and expense, shall repair, correct, renew, or replace any defects or imperfections in the construction, strength, or quality of materials used in or about the construction of the work under the contract, and this payment shall in no way affect his responsibility for all damages due or attributable to such defects or imperfections which may be discovered before the final acceptance of the whole work and the engineer shall be the judge of such defects or imperfections. No monies payable under the contract, except the estimate for the first month or period, shall become due, if the engineer so elects, until the contractor shall satisfy the engineeer that he has fully settled for materials and equipment used in or upon the work and labor done in connection therewith.

All work indicated on the plans as necessary to the completion of the improvement shall be performed by the contractor unless otherwise provided, and all fences, buildings, bridges and structures of any character not necessary to the construction of the roadway, or other encumbrances upon or within the limits of the highway right of way, where indicated on the plans to be removed, unless otherwise provided, shall be removed by the contractor or otherwise satisfactorily disposed of as directed. All unsightly material removed shall be disposed of in such a manner that same will not be visible from the highway. This work will be paid

for as specifically provided for in the various pay items appearing in the proposal and contract, but should no specific provision be made for the payment of this work, it will be considered subsidiary work and as such shall be included by the contractor in the bid prices for pay items appearing in the proposal and contract.

9.03 Increased or Decreased Quantities:

When alterations in plans or quantities of work not requiring "Supplemental Agreements," as hereinbefore provided, are ordered and performed and when such alterations result in increase or decrease of the quantity of work performed, the contractor shall accept payment in full at the contract unit price for the actual quantities of work done and no allowance will be made for anticipated profits. Increased or decreased quantities of work involving "Supplemental Agreements," as set forth in Article 4.03, shall be paid for as stipulated in such agreements.

9.04 Extra and Force Account Work:

Extra work ordered and accepted shall be paid for under a "Supplemental Agreement," "Extra Work Order" or as "Force Account." If the parties at interest are unable to reach an agreement as to the unit prices to be used as the basis of a "Supplemental Agreement" or "Extra Work Order," the engineer may order the contractor to do the work on a force account basis. Extra work not covered by a "Supplemental Agreement," "Extra Work Order" or by a written "Force Account" order will not be paid for.

Payment for extra work will be based upon unit prices previously agreed upon in writing by the parties to the contract. Where such prices cannot be agreed upon or where the engineer deems it impracticable to handle any extra work ordered, on the unit price basis, the "Supplemental Agreement" may be made up in any practical form desired, or the work may be ordered done and paid for on a force account basis.

All extra work done on a force account basis shall be performed by such labor, teams, tools and equipment as may be specified by the engineer.

When work to be performed is to be paid for on a force account basis, the contractor shall furnish itemized

weekly statements to the engineer of the cost of all force account work, together with original receipted bills for all materials used and freight charges paid on same. These weekly statements shall show the following information:

(a) Nature of work performed.

(b) Name, class, dates, number of hours worked each day, total hours, rate and extension, for each laborer, foreman, and team engaged. (Teams and drivers must be carried separately on the statement and likewise must all operators of equipment be carried separately, in order that the amount paid for labor may be determined.)

(c) Designation, number of hours worked each day, total hours, rental rate and extension for each truck, and unit of machinery engaged.

(d) Quantity of materials used, prices and extensions.

(e) Freight on materials.

For all labor, teams, and foremen in direct charge of the specific operation, the contractor shall receive the wage required by the contract in each case or if not specified then the current local rate of wage to be agreed upon in writing before starting the work, to which shall be added an amount equal to 15 per cent of the sum thereof. In addition to the payments above mentioned, the contractor shall be reimbursed in the amount of the actual payments made by him for labor, taxes and insurance. No allowance shall be made for general superintendence and the use of small tools and manual equipment.

For all materials accepted by the engineer and used, the contractor shall receive the actual cost of such material, including transportation charges, to which cost shall be added a sum equal to 10 per cent thereof.

For any machine-power tools or special equipment, including pertinent fuel and lubricants, which it may be deemed necessary or desirable to use, the engineer shall allow the contractor a reasonable rental price to be agreed upon in writing, before such work is begun, for the time that such tools or equipment are in use on the work and to which sum no percentage shall be added.

The compensation as herein provided shall be received by the contractor as payment in full for extra work done on a force account basis, and shall include superintendence, use of equipment for which no rental is allowed, and profit. The contractor's representative and the inspector shall com-

pare records of extra work done on a force account basis at the end of each day. Copies of these records shall be made upon suitable forms provided for this purpose by the inspector and signed by both the inspector and the contractor's representative, one copy being forwarded, respectively, with the monthly estimate and one to the contractor. All claims for extra work done on a force account basis shall be submitted to the engineer by the contractor upon certified statements to which shall be attached original receipted bills covering the cost of, and the freight charges on, all materials used in such work, in order that said statements shall be forwarded with the monthly estimate not later than the twentieth day of the estimate month in which the work was actually performed, and shall include all labor charges, etc., and material charges.

9.05 Partial Payments:

So long as the work herein contracted for is prosecuted in accordance with the provisions of the contract, and with such progress as may be satisfactory to the engineer, the engineer will, on or about the twentieth day of each month, make or have made an approximate estimate of the proportionate value of the work done, up to and including that day. Progress estimates shall be based on material in place and labor expended thereon, but no more than 90 per cent of the contract price of the work shall be paid in advance of the full completion of the contract and its acceptance by the Department.

The amount of said estimate, after deducting 10 per cent and all previous payments, shall be due and payable to the contractor at the office of the Treasurer of the State of Louisiana.

The monthly estimates will be approximate only, 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 in any respect 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.

9.06 Acceptance and Final Payment:

Upon the completion and acceptance of the work, the Chief Engineer shall execute a certificate that the whole work provided for in this contract has been completed and accepted under the terms and conditions of the contract, and said certificate of acceptance shall 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 said contractor, including all retained percentages (all prior certificates or estimates upon which payments have been made being approximate only and subject to correction in the final payment) shall be paid to the contractor at the office of the Treasurer of the State after the Department has satisfied itself that the quantities shown on the final estimate are correct; provided, however, that before the payment of said final estimate shall be made, the contractor shall submit to the Department a certificate from the Recorder of Mortgages of the Parish in which the said 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.

It is expressly stipulated and understood that 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 person or persons whomsoever, through the fault, negligence or conduct of the said contractor or any of his employees.

DIVISION II

CONSTRUCTION DETAILS

Part 1—Earthwork

INDEX

PART 1—DIVISION II

SECTION 1

CLEARING

1.01 Description:

This item shall consist of cutting, removing, burning and clearing up of timber, logs, brush, stumps and debris from within the limits of the entire right of way; also from such areas as may be required for offtake ditches, channel changes and borrow pits furnished by the Department, etc., as directed by the engineer. It shall also include clearing of fruit trees, shrubbery and flowers within the limits of the right of way which are not removed and/or transplanted by their owners, except shrubbery which is to be removed and transplanted by the contractor in connection with the "Removal and Relocation of Buildings and Miscellaneous Structures" and "Moving of Buildings and Miscellaneous Structures," as provided in Section 28, Part 5, Division II. All work under this item shall be done in accordance with these specifications and in conformity with the plans.

1.02 Construction Methods:

All of the surface of the right of way, or as much thereof as the engineer may direct, shall be completely cleared of all trees, logs, stumps, brush, vegetation, rubbish and other perishable or objectionable matter. Such individual trees as the engineer may designate and mark within the areas staked for clearing shall be left standing uninjured. Living trees outside of the roadway lines shall be cut only as directed by the engineer. All trees not required to be moved shall be carefully protected.

Trees, brush, stumps, etc., shall not be deposited on adjacent lands, but shall be disposed of within the limits of the clearing. Trees unavoidably falling outside of the specified limits shall be cut up, removed to within the clearing, and disposed of. Timber of any value which it may be necessary to cut shall be cut into logs of commercial lengths and shall be piled neatly along the right of way on the downstream side, or on abutting property, as directed by the engineer. Cleared material shall not become the property of the contractor. All branches of trees extending within the right of way shall be trimmed as directed, and branches extending over the roadway shall be trimmed carefully to give a clear height of 15 feet over the finished roadway.

Material without value shall be piled in the right of way and burned or otherwise disposed of in such a manner as not to injure any trees or merchantable timber or other property on the right of way or abutting property.

Isolated trees, and stumps projecting more than 6 inches above the ground, shall be cleared. Trees and stumps will be considered isolated when they are 50 feet or more apart.

In clearing, all trees, stumps, brush, etc., shall be cut flush with the ground surface if practicable and in no case shall remain higher than 6 inches above the ground.

MEASUREMENT AND PAYMENT

1.03 Method of Measurement:

Clearing will be measured by the acre and the number of acres shall be determined by measurement of the area actually cleared. Isolated trees or stumps will not be measured or paid for unless a price is included in the contract under Item 1-3-1.

1.04 Basis of Payment:

The number of acres cleared and accepted, measured as provided above, shall be paid for at the contract unit price per acre for "Clearing," which price and payment shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-1-1, Clearing, per acre.

SECTION 2

GRUBBING

2.01 Description:

This item shall consist of the excavation and removal of all stumps, roots, submerged logs, corduroy and other perishable and objectionable materials from within the limits of the slopes; also from such areas as may be required for offtake ditches, channel changes, borrow pits furnished by the Department, as directed by the engineer. All work under this item shall be done in accordance with these specifications and in conformity with the plans.

2.02 Construction Methods:

All stumps, roots and other objectionable materials between slope stakes in cuts and between slope stakes of embankments 2 feet or less in height, shall be removed to a depth of 2 feet below subgrade elevation. In embankments of 2 feet or more in height, all stumps shall be removed flush with the ground surface if practicable and in no case shall remain higher than 6 inches above the ground and shall be paid for as provided in Section 1, Part 1, Division II. All stumps and roots in borrow pits shall be removed if and as directed by the engineer.

All removed material shall be burned or otherwise disposed of as directed by the engineer. Removed material shall not be deposited on adjacent lands. Grubbing with explosives will not be permitted in swampy sections or elsewhere, unless permitted by the engineer.

The grubbing and removal of sod, grass, weeds, crops and other similar objectionable matter will not be paid for as grubbing, but as provided for in the specifications under

the various classes of excavation. Stumps shall be considered isolated when they are 50 feet or more apart.

All excavations or grubbing done below the subgrade surface by the removal of stumps, roots, etc., shall be refilled with suitable material, and compacted thoroughly so as to make the surface at these points conform to the same degree of compaction as the surrounding subgrade.

All grubbing shall be done at least 1,500 feet ahead of the grading operations.

MEASUREMENT AND PAYMENT

2.03 Method of Measurement:

Grubbing will be measured by the acre and the number of acres shall be determined by the measurement of the area actually grubbed. Isolated stumps will not be measured or paid for unless a price is included in the contract under Item 1-3-1.

2.04 Basis of Payment:

The number of acres grubbed and accepted, measured as provided above, shall be paid for at the contract unit price per acre for "Grubbing," which price and payment shall constitute full compensation for furnishing all materials except backfill material furnished under other items, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-2-1, Grubbing, per acre.

SECTION 3

SPECIAL CLEARING AND GRUBBING

3.01 Description:

This item shall consist of the clearing and grubbing of specifically designated trees or stumps from within the limits of the right of way in accordance with these specifications and in conformity with the plans. This item shall apply only where specifically indicated on the plans, or ordered by the engineer.

3.02 Construction Methods:

The methods of construction shall be as provided in Articles 1.02 and 2.02, Part 1, Division II, insofar as applicable hereto.

MEASUREMENT AND PAYMENT

3.03 Method of Measurement:

Special clearing and grubbing will be measured by the tree or stump, and the number of trees or stumps that have been actually cleared and grubbed shall be counted.

3.04 Basis of Payment:

The number of trees or stumps cleared, grubbed and accepted, measured as provided above, shall be paid for at the contract unit price per tree or stump for "Special Clearing and Grubbing," which price and payment shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

No payment will be made under this item for any trees or stumps removed from the area covered by payment under Items 1-1-1 and 1-2-1.

Payment will be made under:

Item 1-3-1, Special Clearing and Grubbing, per tree or stump.

SECTION 4

EXCAVATION AND EMBANKMENT

4.01 Description:

These items shall consist of excavating, removing and satisfactorily disposing of all materials of every character within the limits of the work, except structural excavation and such other work as may be covered by pay items. It shall include excavation for the roadway, inlet and outlet ditches, and for the changing and completion of all channels and all operations necessary for the formation and compaction of embankments, subgrades, shoulders, ditches, slopes, intersections and all other appurtenances necessary for the completion of the work, all in accordance with these

specifications and in conformity with the grades, alignment and cross sections shown on the plans.

Unless otherwise provided, this item shall also include removal and disposal of old surfacing materials, curb, gutter, fences, hedgerows, crops, sidewalks, etc.

4.02 Borrow Excavation:

Borrow Excavation shall include all excavation obtained from borrow pits furnished by the Department, as shown on the plans or designated by the engineer, as special pits to supplement material obtained from within the highway right of way.

Unless otherwise provided in the special provisions, borrow excavation material shall be tested and classified by the laboratory before being placed in embankments and, subject to the restrictions for suitable material hereinafter contained, shall be U. S. Public Roads Administration Soil Identification Classes A1, A2, A3, A4, A6 and/or A7, except that material in the A6 and A7 classes considered unsatisfactory by the engineer will not be accepted, and should a material of the A3 class (sand) be used, the contractor will be required to use on slopes a material of the A4, A6 and/or A7 classification.

No charge will be made against the contractor for material secured from pits furnished by the Department, but the contractor shall construct and maintain, at his own expense, any necessary roads from the pits to the highway.

The Department will secure all necessary easements along the approved routes of haul roads without cost to the contractor.

4.03 Special Borrow Excavation:

Special Borrow Excavation shall include all acceptable excavation obtained from borrow pits furnished by the contractor as special pits to supplement material obtained from within the highway right of way. The site of the borrow pits shall be approved by the engineer.

Unless otherwise provided in the special provisions, special borrow excavation material shall be tested and classified by the laboratory before being placed in embankments and, subject to the restrictions for suitable material hereinafter contained, shall be U. S. Public Roads Administration Soil Identification Classes A1, A2, A3, A4, A6 and/or

A7, except that material in the A6 and A7 classes considered unsatisfactory by the engineer will not be accepted, and should a material of the A3 class (sand) be used, the contractor will be required to use on slopes a material of the A4, A6 and/or A7 classification.

Securing of exclusive option by any contractor on borrow pit areas and/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 used as a basis for rejection of bids or such other action as the Department may deem advisable.

Clearing, grubbing, stripping of pits, and material not used in the embankment will not be measured or paid for; cost of same shall be included in price bid on this item.

The contractor shall provide and maintain all necessary haul roads from the borrow pits to the work at his own expense.

Pits shall be located a minimum distance of 300 feet from the right of way except only as may be otherwise altered by written approval of the Chief Engineer.

4.04 Classification:

All materials excavated except Borrow Excavation and Special Borrow Excavation shall be unclassified and paid for as Common Excavation regardless of the material encountered, unless a classification is indicated on the plans and separate items shown in the contract.

When such classification is indicated in the contract, excavation shall be classified as follows:

Common Excavation.
Drainage Excavation.
Muck Excavation.

Common Excavation: Common Excavation shall include all excavation under this item, except Borrow Excavation and Special Borrow Excavation, when no Drainage Excavation or Muck Excavation is shown on the plans or indicated in the contract. When either or both Drainage Excavation or Muck Excavation is indicated, Common Excavation shall include all excavation except Borrow Excavation and Special Borrow Excavation and the indicated classified material.

Drainage Excavation: Drainage Excavation shall include all required excavation under this item beyond the

limits of the roadway section for inlet and outlet ditches to structures and roadway; changes in or deepening of channels of streams, berm ditches, ditches parallel to or adjacent to roadway, and ditches draining borrow pits. Material excavated from under existing bridges will also be classified as Drainage Excavation.

Muck Excavation: Muck Excavation shall include the excavation of unsatisfactory overburden covering clay or other suitable material in swamp or marsh areas. Muck shall include such materials as 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 shall determine the material to be classified as muck and wasted and the material that is satisfactory for use in the embankment in accordance with the specifications.

CONSTRUCTION METHODS

4.05 General:

While the excavation is being done and until the work is finally accepted, the contractor shall take the necessary steps to protect the work and to prevent loss of material from the roadway. During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

When required by the engineer, surface or berm ditches shall be cut on the top of slopes of excavation, or at the foot of slopes of embankments, and at such other points as may be designated.

4.06 Common Excavation:

All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankments, subgrade, shoulders and at such other places as directed. No excavated material shall be wasted without written permission from the engineer and when such material is to be wasted, it shall be disposed of as directed by the engineer. When more material is required, the engineer in locating same, shall give preference to the widening of cuts on the inside of curves. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the road-

way, the roadbed shall be maintained in such condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be constructed so as to avoid damage to embankments by erosion. Under no conditions shall holes be gouged or dug in back slopes or in embankments to obtain material for curing concrete pavements, for constructing shoulders or for any other purpose.

All common excavation shall be unclassified and the contractor will not be allowed any additional compensation for excavating existing surfacing material or rock excavation that may be encountered in performing the work unless specifically provided for.

Any material excavated by the contractor beyond the limits of the typical cross section of the roadway, where such material is not needed for constructing the embankment, shall be at the contractor's expense and will not be paid for. The engineer may require such material to be satisfactorily replaced.

Fences or pipe culverts which are to be re-used or salvaged, shall be removed with care and piled or disposed of in a manner acceptable to the engineer.

All pipe culverts and wooden culverts and bridges to side roads and private drives shall be removed, where required, and immediately replaced after completion of the improvement at the site. No direct payment will be made for removing and replacing these structures unless specifically provided for by the contract.

4.07 Drainage Excavation:

The contractor shall perform the drainage excavation at the time the rough grading is done unless otherwise directed by the engineeer. The contractor shall dispose of the excavated material as directed by the engineer and suitable material shall be placed in the embankment and berm or used for widening same when shown on the plans or directed by the engineer. All roots, stumps and other obstructions in the sides and bottoms of ditches shall be cut to conform to the required cross section and grade. No excavated material from ditches shall be deposited or left within 3 feet of the edge of the ditch. All ditches excavated by the contractor shall be maintained free from earth, sticks or other debris until final acceptance.

4.08 Muck Excavation:

Material excavated as Muck Excavation shall be disposed of as indicated on the plans or as directed by the engineer.

4.09 Borrow Excavation and Special Borrow Excavation:

Borrow shall only be used when sufficient quantities of suitable material are not available, as herein prescribed, from Common and Drainage Excavation, to properly construct the embankments, subgrade, and shoulders, and to complete the backfilling of structures. No material shall be removed from the borrow pits until they have been cross sectioned and measured by the engineer and the contractor shall notify the engineer of the opening of any borrow pit sufficiently in advance to permit such cross sections and measurements to be taken. Borrow pits which are visible from the highway shall be neatly trimmed and unsightly stumps removed to the satisfaction of the engineer. All borrow pits shall be left in a neat and suitable condition to facilitate the accurate measurements of the materials used and shall be properly drained to the satisfaction of the engineer.

4.10 Embankments, Other than Dredged and Hydraulic:

Embankments shall be formed of approved material obtained from excavation under the items applying and placed in successive horizontal layers not exceeding 8 inches loose depth, except as hereinafter provided, distributed uniformly over the full width of the cross section and thoroughly compacted.

Sod, grass, weeds, and any other objectionable matter shall be removed from within the limits of slope stakes.

When embankments are made on a hillside, sloping more than 20 degrees from the horizontal, the slope of the ground on which the embankment is to be placed shall be plowed deeply or cut into steps before the filling is commenced. Where a new road is to be constructed on an old one, the old road shall be plowed or scarified and broken up full width, regardless of height of fill.

Fill shall be constructed in lengths of not less than 300 feet or for the full length of the fill if less than 300 feet. Stumps, roots, brush, sod, rubbish or any other unsuitable material shall not be placed in the embankment.

Where the material from which embankments are being constructed is of variable quality, the contractor shall so arrange his operations that the top one foot of embankment may be constructed of suitable material as directed by the engineer.

When dragline excavators are used in building embankments or where the material is hauled and dumped with trucks, or other vehicles, the material must be spread in successive layers, not exceeding 8 inches loose depth, over the entire cross section by a road grader, fresno, bulldozer, or other approved equipment.

Draglines will not be permitted to operate with any part of the weight of same resting on existing pavement. This does not prohibit moving a dragline over the pavement provided permission is first obtained from the engineer and proper precautions are taken to protect the slab.

Except when specifically provided for by the plans and special provisions, dumping trestles will not be allowed in the construction of embankments without the written permission of the engineer and when permitted, the construction of the embankment shall be subject to such additional requirements as the engineer may deem advisable.

In backfilling around and over culverts, abutments and retaining walls, the embankment end of weep holes shall be covered with at least 2 cubic feet of clean, broken stone or gravel, so placed as to allow free drainage. From approximately 6 inches below the bottom of the outside ends of the weep holes, a column of clean broken stone or gravel, at least one foot square, shall be carried up against the back of the wall to the surface of the original ground. A sufficient quantity of stone or gravel shall be left by the contractor to enable him to continue this column of stone or gravel up to the elevation of subgrade, or, in the case of culverts, to the top of the top slab.

No backfilling shall be placed against any masonry abutment, wing wall or culvert until permission shall have been given by the engineer and in no case until the masonry has attained the minimum specified strength.

Embankments that are placed against bridge abutments, retaining walls or other structures and open end bents must be built in horizontal layers not exceeding 6 inches loose depth and for a distance, measured from the end of the structure along the center line of the road, equal to 1½

times the height of the structure above the existing ground line and must be thoroughly compacted by mechanical tamping. This method of building the embankment will extend to such height above the structure as the engineer may direct. Each layer of fill material shall be compacted to the specified density at optimum moisture as provided in Article 4.11. Embankments over and around pipes, culverts, arches and bridges shall be made with selected materials placed, tamped, puddled, or otherwise compacted as directed by the engineer, so as to avoid undue strain on the structure.

All surplus excavation and waste material shall be used uniformly to widen embankments or flatten the slopes, or deposited in such other places and for such purposes as the engineer may direct.

When required by the plans the top of the embankment, in both cut and fill sections, shall be constructed of suitable material. The term "suitable material" shall be interpreted to mean selected materials of Public Roads Administration classes A1, A2, A3 and/or A4, or as modified by the plans or special provisions. The term "unsuitable material" shall be interpreted to mean material not meeting the requirements set forth above or material which is otherwise objectionable for use in the top of the embankment. Where existing suitable material is found in place, the contractor shall perform either of the following operations as specified and as required by the plans. (1) Such material shall be plowed or otherwise scarified by methods satisfactory to the engineer to the width and depth indicated on the plans. Where additional material is needed to obtain the required section, a sufficient quantity of suitable material shall be placed. (2) Such material, in both cut and fill sections, shall be removed to the depth indicated on the plans. Suitable material so removed may be replaced in the same cut or fill. If the contractor elects, and provided that no additional overhaul is involved, the removed suitable material may be used in other cuts or in the embankment, and new suitable material substituted therefor. In any event, sufficient suitable material shall be furnished and placed to provide the compacted thickness shown on the plans. All unsuitable material, both in cuts and fills, shall be removed to the depth indicated on the plans and replaced with suitable material. Material unsuitable for use in the top of the

embankment, removed as provided above, may be used in the base of embankments if it has been approved by the engineer; otherwise, the unsuitable material shall be disposed of by the contractor in a manner satisfactory to the engineer.

All of the operations required in connection with the placing of embankment as herein described, shall be considered as incidental to the work of excavation, and additional compensation will not be made for performing the work in the manner hereinbefore described.

4.11 Compaction of Embankments:

Compaction of embankments shall be accomplished by any satisfactory method or methods that will obtain the density hereinafter specified, unless a specific method is provided by the special provisions.

The density of compacted material in each layer of an embankment shall not be less than the percentage of the maximum density (Method of Test for the Compaction and Density of Soils, A.A.S.H.O. Designation: T 99) shown in the following table:

Type of Pavement	Minimum Compaction Permitted, Percentage of Maximum Density Obtained by A.A.S.H.O. Method
Aggregate Type of Surfacing	90
Asphalt Type of Surfacing	95
Portland Cement Concrete Pavement	95

The wetting of each layer may be done with a water wagon or other approved sprinkling device but the device used shall be capable of delivering not less than 60 gallons per minute at the discharge end.

All embankment compaction operations shall be under the direct supervision of the engineer, and these operations shall proceed in such sequence as he may direct. The engineer shall determine by approved methods and standard tests the amount of water which will uniformly and sufficiently moisten the soil, and in addition and at the same time provide for the proper total moisture content in the embankment material which will obtain the specified degree

of compaction in the embankment. Embankment material containing excess moisture shall be permitted to dry to the proper consistency before being compacted. The contractor shall be responsible for correctly applying the water to the soil, for correctly mixing the water with the soil, manipulating the soil and the water to the proper uniform moisture content before beginning compaction, and finally compacting the properly moistened embankment material uniformly to the degree of compaction required in these specifications. The contractor shall be responsible for the stability of all embankments made 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 storms, etc., and not attributable, in the opinion of the engineer, to unavoiadble movements of the ground upon which the embankment is made.

Compaction of embankment adjacent to structures, etc.: In those portions of the embankment which are adjacent to structures or are for other reasons inaccessible to the equipment used, the contractor shall use mechanical tampers approved by the engineer, to obtain the specified density. Hand methods of compaction will not be permitted.

4.12 Subgrade:

The subgrade is that portion of the roadbed upon which the wearing course or base course is to be placed, except that for concrete pavement or pavements having a concrete base, the subgrade shall be interpreted to include an additional area extending one foot on each side of the concrete pavement or base. No payment for excavation will be allowed for this additional width.

All soft and yielding material, muck, boulders and loose stones, and other portions of the subgrade which will not compact readily shall be removed and replaced with suitable material, tamped if required, and the whole subgrade brought to line and grade and to a foundation of uniform compaction and supporting power. All large, loose rocks or boulders extending close to the surface of the subgrade shall be broken off 12 inches below the surface of the subgrade and removed. Where the subgrade surface is of a compacted nature, or where required by the plans, it shall be plowed to a depth of not less than 6 inches for the full

width of the subgrade. The loosed material shall then be spread and manipulated so as to bring all the material 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 elevation.

The subgrade shall be properly shaped, rolled and uniformly compacted so that it conforms to the lines and grades as shown, before any roadway material is placed thereon, and shall be brought to a firm unyielding surface by rolling the entire area in such manner as to obtain the density specified. Any portion of the subgrade that is inaccessible to the roller shall be compacted thoroughly with mechanical tampers weighing not less than 50 pounds, the bearing or tamping face of which shall not exceed 100 square inches in area. Under no conditions shall material for backfill be taken from embankments to a greater depth than subgrade elevations or from holes dug in the back slopes. Should sufficient time elapse between the rough grading and the laying of surface or base course to allow the earth to become baked and hardened, the surface shall be scarified and rerolled. Any frozen material shall be removed, if required, before placing any surfacing material on the subgrade, and shall be replaced with suitable material. In preparing the subgrade, the material excavated shall not be piled outside and along the forms in such a manner as to interfere with the proper operation of all the finishing tools.

After the subgrade has been prepared as specified above, the contractor shall maintain it free from ruts and depressions and all damage resulting from the hauling or handling of any materials, equipment, tools, etc., and if ruts are formed, the subgrade shall be scarified and rolled, or thoroughly tamped. The subgrade shall be planked to prevent further rutting, if necessary in the opinion of the engineer. Ditches and drains shall be finished and maintained along the completed subgrade section. The subgrade shall be in final condition for receiving the surface or base course for a distance of at least 500 feet in advance of the placing of the surfacing materials, forms, etc. No surfacing materials, forms, etc., shall be placed until the subgrade has been approved by the engineer.

If the roadbed under construction is over the traveled way of an old road or a furrowed field, then the area covered by the roadbed shall be thoroughly plowed and scarified to a depth of 6 inches below the original surface or as directed by the engineer, after which it shall be reshaped and rolled as hereinbefore specified.

4.13 Shoulders, Ditches and Slopes:

Before any subgrade shall be approved, the adjacent shoulders shall be constructed to the full width and at least to the level of the finished subgrade, but not necessarily to the final height and shape. At all times construction shall be so carried on that the subgrade, shoulders and adjacent slopes and ditches will be effectively and completely drained. This work shall be done in proper sequence with any base or surface course construction, as directed. In the case of surface courses or base courses of a design or condition so requiring, the shoulders shall be sufficiently built up against the edges of such work as may be necessary to sustain it immediately after the laying. Upon the completion of the course the earth shoulders, slopes and side ditches shall be shaped true to the cross section shown on the plans.

Progress on shoulders and ditch work shall not be more than 4,000 feet behind the last laid pavement or surfacing, except in the case of concrete pavements where the curing period has not elapsed or where an industrial system is used. All shoulders shall be compacted to the density required for subgrade by the use of equipment satisfactory to the engineer, except that when the plans indicate that shoulders are to be sodded, the surface soil on the shoulders to a depth of 4 or 5 inches shall be left loose. The cost of constructing shoulders is included in the unit price bid for "excavation" and no additional payment will be made for the construction of same.

MEASUREMENT AND PAYMENT

4.14 Method of Measurement:

Excavation, except drainage excavation and muck excavation, will be measured by either of the following methods as indicated on the plans:

(1) Excavation will be measured by the cubic yard and the number of cubic yards shall be determined by

measurement in its original position by the method of average end areas.

(2) Excavation will be measured by the cubic yard and the number of cubic yards shall be determined by measurement in its final position in the embankment by the method of average end areas.

Drainage excavation will be measured as provided in paragraph (1) above.

Muck excavation will be measured as provided in paragraph (1) above. The measurement of muck excavation shall include only such material as is excavated within the lines and grades indicated on the plans or directed by the engineer.

Excavation incidental to the removal of all existing drainage structures, except where a pay item is specifically provided for the removal of the structure, will be measured. The quantity of excavation to be measured will be that determined by vertical planes one foot outside and parallel to the outside lines of the portions of the structure actually removed and the actual depth of the material removed.

Excavation incidental to the construction of new culverts or other structures will not be measured unless specifically provided for on the plans. When provided, the quantity of excavation to be measured will be that determined by vertical planes one foot outside and parallel to the outside lines of the new structure, and the actual depth of material removed. Such excavation will be classified as common excavation.

Materials excavated which are used for purposes other than shown on the plans or designated by the engineer will not be measured or paid for. Materials excavated outside the lines and grade given by the engineer, unless specifically authorized by the engineer, will not be measured or paid for. Slides and falls and insecure masses of material beyond the regular slopes not due to carelessness or lack of precaution on the part of the contractor when ordered by the engineer to be utilized or disposed of, will be measured and paid for.

In the event embankment measurement is indicated on the plans, the quantity of material to be measured shall be that which is included in the typical section for the embankment on the plans, above the original ground line, as determined from actual cross sections taken of same just prior to beginning construction of the embankment,

and below the upper limits of said typical section, or below the upper limits of the grade established on the plans or by the engineer on construction. The Department, as near as possible, will predetermine the shrinkage factor and will indicate same on the plans; however, the theoretical shrinkage factor will be shown for informational purposes only and measurement will be made as provided above. No material outside the established lines and grades will be measured or paid for except slides or insecure masses of material which are not to be utilized in the embankment but are to be otherwise disposed of as directed by the engineer. Insofar as possible all materials required for the embankment shall be secured from within the limits of the highway right of way. When additional material is required to supplement material obtained from within the limits of the right of way, such material shall be obtained from borrow pits furnished by either the Department or the contractor, as shown on the plans or in the special provisions.

4.15 Basis of Payment:

(a) Material measured in its original position as provided under method (1) of Article 4.14:

When no classification of material is indicated on the plans, the total quantity of accepted excavation, except Borrow Excavation and Special Borrow Excavation, determined as provided above shall be paid for at the contract unit price per cubic yard for Common Excavation. When a classification of material is indicated on the plans, the quantities of the various classes of materials, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Common Excavation," "Drainage Excavation" or "Muck Excavation." The quantity of Borrow Excavation and Special Borrow Excavation determined as provided above shall be paid for at the contract unit prices per cubic yard for "Borrow Excavation" or "Special Borrow Excavation." The contract unit price and payment for any of the above items shall constitute full compensation for all work described under this section, and shall include the removal of all obstructions as specified herein; the formation of embankments; backfilling around structures; preparation of subgrade; dressing shoulders, ditches, slopes, borrow pits; all hauling (unless an item for "Overhaul" is included in the contract); disposal of all surplus materials;

the removal of vegetation where an item of clearing or grubbing is not provided; wetting and compacting by rolling or otherwise; and shall also include the furnishing of all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-4-1, Common Excavation, per cubic yard.
Item 1-4-2, Drainage Excavation, per cubic yard.
Item 1-4-3, Muck Excavation, per cubic yard.
Item 1-4-4, Borrow Excavation, per cubic yard.
Item 1-4-5, Special Borrow Excavation, per cubic yard.

(b) Material measured in place in the embankment as provided under method (2) of Article 4.14:

All material entering into the construction of the embankment shall be unclassified.

The number of cubic yards of embankment material complete in place and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Embankment," which price and payment shall constitute full compensation for the removal of all obstructions as specified herein; the formation of embankments, backfilling around structures; preparation of subgrade; dressing shoulders, ditches, slopes, borrow pits; all hauling; disposal of surplus materials not to be utilized in the embankment; the removal of vegetation where an item of clearing or grubbing is not provided; wetting and compacting by rolling or otherwise; and shall also include the furnishing of all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-4-6, Embankment, per cubic yard.

SECTION 5

STRUCTURAL EXCAVATION

5.01 Description:

This item shall include the excavation for abutments and piers for all types of bridges and the satisfactory disposal of the material excavated.

CONSTRUCTION METHODS

5.02 General:

The contractor shall notify the engineer a sufficient time in advance of the beginning of excavation for structures, so that the cross sectional elevations and measurements may be taken of the undisturbed ground. Any materials removed or excavated before these measurements have been taken will not be paid for. The natural ground adjacent to the structures shall not be disturbed without permission of the engineer.

Trenches or foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the plans or as staked by the engineer. They shall be of sufficient size to permit the placing of the full width and length of structure or structure footings shown. The elevations 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 elevations of footings as may be deemed necessary to secure a satisfactory foundation.

Boulders, logs, or any other unforeseen obstacles encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface, either level, stepped, or serrated, as directed by the engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When masonry 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 masonry is to be placed. Where foundation piles are used, the excavation of each pit shall be completed before the piles are driven. After the driving is completed, all loose and displaced material shall be removed, leaving a smooth solid bed to receive the masonry.

No classification of stuctural excavation will be made, regardless of material encountered, unless specifically stated in the special provisions.

5.03 Disposal of Material:

All excavated material, so far as suitable, shall be utilized as backfill or embankment. The surplus material, whether or not temporarily allowed to be placed within the

stream area, shall be disposed of finally in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure. No excavated material shall be deposited at any time so as to endanger the partly finished structure, either by direct pressure or indirectly by overloading banks contiguous to the operation, or other manner.

5.04 Cofferdams:

Suitable and practically watertight cofferdams shall be used wherever water-bearing strata are encountered above the elevation of the bottom of the excavation. Upon request, the contractor shall submit drawings showing his proposed method of cofferdam construction and other pertinent features not shown in detail on the plans. Such drawings shall be approved by the engineer before construction is started, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement.

Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as watertight as practicable. In general, the interior dimensions of cofferdams 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 or enlarged so as to provide the necessary clearance and this shall be at the expense of the contractor.

When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, the engineer may require the construction of a concrete foundation seal of such dimensions as may be necessary, and of such thickness as to resist any possible uplift; concrete for such seal shall conform to all the special requirements for "Depositing Concrete under Water," Article 5.19, Part 4, Division II. The foundation shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight is utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib

onto the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at a low-water level as directed.

Cofferdams shall be constructed so as to protect green concrete against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission from the engineer.

Any pumping from the interior of any foundation enclosure that may be permitted shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it is done from a suitable pump separated from the concrete work by a watertight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdams or cribs with all sheeting and bracing involved therewith shall be removed by the contractor after the completion of the substructure and backfill. The removal shall be effected in such manner as not to disturb or mar the finished masonry. No permanent piling shall be driven outside the cofferdam in close proximity thereto prior to completion of backfilling and removal of the cofferdam unless authorized by the engineer.

5.05 Depth of Footing:

The elevations 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 elevations of footings as may be necessary to secure a satisfactory foundation.

5.06 Approval:

After each excavation is completed, the contractor shall notify the engineer, and no masonry shall be placed until after the engineer has approved the depth of the excavation and the character of the foundation material.

5.07 Backfilling:

After the structure has been completed, the areas around the foundations shall be filled with approved material, in horizontal layers not over 6 inches in depth and

compacted satisfactorily to the level of original surrounding surfaces.

No backfilling shall be placed against any abutment, wing wall or retaining wall until permission shall have been given by the engineer. In the case of concrete or other masonry, such permission will preferably not be given until the masonry has been in place 14 days, or until tests made by the laboratory under the supervision of the engineer have established that the concrete has attained sufficient strength to withstand any pressures created by the methods used and materials placed without damage or strain beyond a safe factor.

Adequate provision shall be made for thorough drainage and drains shall be placed at weep holes.

Fill placed around piers shall be deposited on both sides to approximately the same elevation at the same time. All filling adjacent to structures shall be deposited in horizontal layers and compacted as prescribed. Special care shall be taken to prevent any wedging action against the structure and all slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent such wedge action.

In backfilling abutments, retaining walls or other structures, the bed for the backfill shall be so prepared and serrated and the backfill shall be so built up in horizontal layers that at all times there shall be a horizontal berm of thoroughly compacted material beyond the structure for a distance at least equal to the height of the abutment or wall to be backfilled except insofar as undisturbed material obtrudes into this area. Each layer of this berm shall be compacted by tamping with approved mechanical tampers to the specified density at optimum moisture.

By mechanical tamper is meant equipment designed to tamp the relatively thin layers herein prescribed. The use of drop pile hammers, loaded or unloaded clam shell buckets or other similar unsuitable equipment for this purpose is prohibited within the berm area mentioned above as well as the dropping of any heavy weight for the purpose more than 10 feet. Jetting of fills, or other hydraulic methods involving or likely to involve liquid or semiliquid pressure within this berm area, is prohibited within the area contiguous to the abutment or wall to be backfilled and for a distance therefrom equal to 2½ times the height thereof above low water.

MEASUREMENT AND PAYMENT

5.08 Method of Measurement:

The yardage to be paid for shall be the number of cubic yards, measured in original position, of the material acceptably excavated as hereinbefore prescribed, except that, unless such excavation is ordered in writing, no yardage shall be included of excavation outside of a volume bounded by vertical surfaces, 12 inches outside of the neat footings and parallel thereto. The cross sectional area measured shall not include water or other liquid but shall include mud, muck or similar semisolid material which has not been disturbed by the contractor and which cannot be drained away.

When it is necessary, in the opinion of the engineer, to carry the foundations below the elevations shown on the plans, the excavation of the first 3 feet of additional depth will be included in the quantity for which measurement will be made under this item. Excavation below this additional depth will be paid for as extra work.

Yardage of rehandling and excavation for pile bents not having a footing shall not be included. No measurement shall be made for any backfill.

No measurement will be made under this item for excavation for structures which are designated as culverts on the summary of drainage structures in the plans, or for excavation required to construct pile bents at bridge ends.

5.09 Basis of Payment:

The number of cubic yards, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Structural Excavation," which price and payment shall constitute full compensation for all excavation, for furnishing, placing, moistening, and compacting backfill material, as required; for disposing of surplus material; for any clearing and grubbing work involved but not intended to be covered under "Clearing" or "Grubbing;" for all bailing, draining, and sheeting; for the construction of cribs or cofferdams, unless otherwise provided; for furnishing all materials, and for all labor, equipment, tools and incidentals necessary to complete the item.

No payment will be made under this item for excavation for culverts or end bents of bridges; the cost of same

unless otherwise provided on the plans shall be included in contract unit prices for the several items that constitute the structure.

Payment will be made under:

Item 1-5-1, Structural Excavation, per cubic yard.

SECTION 6

OVERHAUL ON EXCAVATION

6.01 Description:

This item shall consist of such hauling in excess of 2,000 feet as required by the contract or as directed by the engineer of material paid for under "Excavation," and placed on the highway.

MEASUREMENT AND PAYMENT

6.02 Method of Measurement:

The limits of free haul for excavation shall be determined from a mass diagram of actual construction quantities by fixing on the volume curve 2 points such that the distance between them, measured along the center line of the highway equals 2,000 feet, and the included quantities of excavation and embankment balance. All material within this free haul limit shall be eliminated from further consideration.

Overhaul will be measured by the station yard and the quantity of overhaul shall be determined by multiplying the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in feet, divided by 100. The overhaul distance shall be the distance, measured along the center line of the highway between the centers of volume of the overhauled material in its original position and after placing, less 2,000 feet.

Where material is secured from borrow pits furnished by the Department, outside the limits of the highway right of way, the hauling shall be performed over the shortest practical route as determined by the engineer and the overhauled distance shall be the distance thus determined less 2,000 feet.

6.03 Basis of Payment:

The quantity of overhaul, measured as provided above, shall be paid for at the contract unit price per station yard for "Overhaul on Excavation," which price and payment shall constitute full compensation for all hauling and the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

No payment will be made under this item for overhaul on "Special Borrow Excavation," Item 1-4-5, and "Structural Excavation," Item 1-5-1.

Payment will be made under:

Item 1-6-1, Overhaul on Excavation, per station yard.

SECTION 7

DREDGED EMBANKMENTS

7.01 Description:

This item shall consist of dredging acceptable material from designated canals, placing the material in embankments and dressing and completing the embankment all in accordance with the specifications and in conformity with the lines, grades and typical cross sections shown on the plans.

7.02 Permits:

Unless otherwise provided in the contract, the contractor must, at his own expense, procure all necessary permits from proper authorities, to operate dredges and other floating equipment in waters under their control. Failure to procure any such permits will not operate to release the contractor or his bonding company from responsibility for completion of the work within the time limit.

7.03 Equipment:

The dredge to be used shall be approved by the engineer. The length of boom shall be such as to reach to or above the shoulder farthest from the canal, in order that the material may be dropped into place directly from the dipper. Bank spud type dredges shall not be used.

7.04 Material:

Material used in the embankment must be free from all decayed matter, roots, stumps, logs or other material considered by the engineer to be unfit for incorporation in the embankment.

CONSTRUCTION METHODS

7.05 General:

In placing material excavated by the dredge, the bucket or dipper will be swung into place and shall be lowered to within 2 feet of the original ground or the previously placed material before being opened. In no case shall excavated material be dumped in a pile on the berm or within the area to be occupied by the completed embankment. Successive buckets of material shall be deposited uniformly across the width of the embankment so that uneven loading of the embankment shall not occur. Material considered unfit for incorporation in the embankment shall be placed on the side of the canal farthest from the roadway at such a distance from the edge of the canal as will preclude sloughing.

The embankment shall be constructed in 2 or more layers, the thickness of the first layer being determined by the depth of canal necessary to float the dredge. Each layer shall be bladed with a bulldozer, tractor and blade, or other approved equipment.

7.06 Cross Section of Canal:

The depth of canal on the embankment side shall be only sufficient to float the dredge. The depth shall increase in the direction away from the embankment to a point ⅘ the width of the canal, at which point the depth shall be the maximum allowable by the conformation of the dredge. From the ⅘ point, the bottom of the canal shall slope up to the canal bank. In no case will the construction of a canal having vertical sides and flat bottom be allowed.

The undercutting of slopes shown on the plans is expressly prohibited.

7.07 Berm:

The width of the berm shall be shown on the plans.

7.08 Dressing Embankment:

When the embankment is completed the top and side slopes shall be carefully dressed to the satisfaction of the engineer.

MEASUREMENT AND PAYMENT

7.09 Method of Measurement:

Dredged embankment will be measured by the cubic yard and the yardage shall be determined by measurement of the original space occupied by the material, computed by the method of average end areas. Cross sections will be taken along the center line at intervals not exceeding 50 feet. Measurement will be made within 48 hours after excavation and, on progress estimates, the payment will not cover yardage closer than 200 feet in the rear of the dredge.

7.10 Basis of Payment:

The number of cubic yards of material placed and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Dredged Embankment," complete in place, which price and payment shall constitute full compensation for furnishing all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-7-1, Dredged Embankment, per cubic yard.

SECTION 8

HYDRAULIC EMBANKMENT

8.01 Description:

This item shall consist of dredging and pumping acceptable materials from lakes, canals or other designated places, placing this material in embankments, and dressing and completing the embankment, all in accordance with the specifications and in conformity with lines, grades and typical cross sections as shown on the plans.

8.02 Permits:

Unless otherwise provided in the contract, the contractor must, at his own expense, procure all necessary

permits from proper authorities to operate dredges and other floating equipment in waters under their control. The contractor shall also obtain all necessary permits for the passage of the discharge pipe over private property. Failure to procure any such permits will not operate to release the contractor or his bonding company from responsibility for completion of the work within the time limit.

8.03 Equipment:

The contractor shall furnish dredging and hydraulic equipment adequate to insure completion of the work within the time specified in the contract. All equipment shall be subject to approval by the engineer.

8.04 Material:

The engineer shall decide what materials may be used for construction purposes. In the event information is shown on the plans as to the availability of material suitable for hydraulic embankment, it is understood that these data are for the information and guidance of the contractor, but the Department does not guarantee the depth, extent and character of the material so indicated. No additional compensation will be allowed the contractor should it develop during construction that the material is of a different nature from that indicated on the plans.

It is the responsibility of the contractor to make such examination of the site of the work and all sources of material as may be necessary to inform himself of the conditions under which the work is to be performed.

There will be no classification of material for purposes of payment.

CONSTRUCTION METHODS

8.05 General:

No material for the embankment shall be obtained from sources closer than 500 feet from the toe of the slope of the embankment shown on the plans, unless otherwise specifically provided. The engineer shall have authority to reject materials considered by him to be unsatisfactory for use in the embankment and such materials shall be stripped at the contractor's expense before the embankment is built. The contractor shall remove all muck and unsuitable

material to the line, grade and section shown on the plans. Any muck or other unsatisfactory material brought to the top of the embankment shall be removed by the contractor at his own expense and satisfactory material substituted therefor. In placing the material in the embankment, the contractor shall begin at the center line and deposit material in either or both directions towards the toes of the slopes and the discharge shall always be in the direction of, and along or parallel to the center line, unless otherwise permitted by the engineer. If the discharge of the material from the pipe line shall cause erosion or damage to existing work or property to an extent considered dangerous by the engineer, the work shall be stopped until such methods of discharge are effected as to prevent such damage. Material shall be deposited in such manner as to maintain at all times a higher elevation at the center of the roadway than on either side. The contractor will not be permitted to construct retaining levees along the highway of such dimensions as to cause subsidence and upheaval in the foundation of the roadway. The contractor shall so conduct his operations as to insure the completion of an embankment which will conform to the cross section shown on the plans except that he will be permitted to flatten side slopes. However, if material is deposited on private property, the contractor shall obtain satisfactory permission from the property owners affected. The contractor shall take all necessary precautions to prevent the filling of streams. The contractor will be required to assume all responsibility for compression, subsidence, displacements or slides that may take place or be assumed to have taken place in the hydraulic fill and no payment will be made for materials that may, by displacement or by the filling of subsurface channels or voids, find its way beyond the limits of the net pay section. The contractor shall provide sufficient material to maintain the embankment in accordance with the typical section as shown by the plans, until the project is accepted by the engineer. The contractor shall hold the State harmless against any and all claims for damages occasioned by his operations.

Where pipe lines cross the surface of an existing traveled highway, they shall be satisfactorily bridged as directed by the engineer, and traffic protected by the display of warning signals both day and night. If the operation of the pipe line or other activities of the contractor should

cause such damage to an existing traveled highway that traffic is stopped, the engineer shall require the contractor to stop operation of the dredge until satisfactory repairs to the highway are effected and traffic resumed, and until proper precautions are taken to prevent further damage.

MEASUREMENT AND PAYMENT

8.06 Method of Measurement:

Hydraulic embankment shall be measured by the cubic yard and the quantities shall be computed by the average end area method. The following method shall be used for measurement:

Cross sections of the area to be covered by the embankment shall be taken before the ground is disturbed or any material placed thereon. These cross sections shall extend laterally from the center line to the toes of the slopes as indicated on the typical section and the elevations as determined by these sections shall be considered the original ground line. The pay quantity of hydraulic embankment to be measured shall be the volume of material included in the section above the original ground line and below the upper limits of the typical cross section, including the quantity of material required for filling the muck ditch. The quantity of material allowed for filling the muck ditch shall be determined by the fixed width of the muck ditch indicated on the typical cross sections of the plans and the actual depth of muck or other unsuitable material removed therefrom. The actual depth shall be construed to mean the depth below the original ground line. No measurement will be made under this item for payment for excavation of muck ditch but same will be classified and paid for as "Muck Excavation," Item 1-4-3. Material outside of the limits of the typical cross sections, as shown on the plans, will not be measured or paid for.

8.07 Basis of Payment:

The number of cubic yards of material placed and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Hydraulic Embankment," complete in place, which price and payment shall constitute full compensation for placing all material and for dressing the top and side slopes of the embankment, either to the slopes shown or to a flatter slope, if

allowed by the engineer, together with the furnishing of all materials, equipment, tools, labor and incidentals and the performance of all work ncessary to complete the item.

Payment will be made under:

Item 1-8-1, Hydraulic Embankment, per cubic yard.

SECTION 9

SODDING

9.01 Description:

These items shall consist of furnishing topsoil, when required by the plans, and of furnishing, hauling, planting, watering, rolling and maintaining live Bermuda grass sod, live carpet grass sod, or some other sod approved by the engineer and native to the locality of the work. The topsoil, when required, and sod shall be placed at locations shown on the plans or directed by the engineer. The items shall include the surface dressing of all areas to be sodded except when a pay item for surface dressing is included in the contract.

9.02 Classification:

Sodding shall be classified as follows:

Sprig Sodding
Tuft Sodding
Slab Sodding
Mulch Sodding
Broadcast Sodding

Sprig Sodding shall consist of sprigs of sod planted 12 inches center to center.

Tuft Sodding shall consist of tufts of sod 3 inches wide and 2½ inches thick planted to form continuous rows parallel to the highway center line. The rows of sod shall be planted 12 inches apart, center to center.

Slab Sodding shall consist of slabs of sod 12 inches wide and 2½ inches thick planted side to side and completely covering the area to be sodded.

Mulch Sodding shall consist of a combination of grass roots and topsoil spread to a depth of 4 inches or less, as directed by the engineer, over the area to be sodded.

Broadcast Sodding shall consist of Bermuda roots and tops which may be "bare-rooted" or which may contain a small amount of soil attached to the roots.

9.03 Equipment:

All equipment specified shall be on the project and in working condition before any sodding operations are started and shall consist of the following:

A soil pulverizer or cultipacker weighing not less than 500 pounds and not more than 1,500 pounds which shall be either a single or double gang type.

Approved water wagons or tanks of sufficient capacity or other sprinkling devices.

Necessary plows, disks, scarifiers and/or harrows.

Required bulldozers, blades and/or drags, rollers and other necessary tools and equipment.

9.04 Materials:

Sprig Sodding, Tuft Sodding and/or Slab Sodding shall consist of sprigs, tufts or slabs of sod composed of Bermuda grass, carpet grass or some other grass approved by the engineer and native to the locality of the work. The sod shall be free from noxious weeds and other objectionable vegetation. The sod shall be furnished by the contractor and placed as provided in these specifications.

Mulch sod shall consist of a combination of grass roots and top soil dug to a maximum depth of 6 inches. The contractor shall notify the engineer of the location where mulch sod is to be obtained and the engineer may inspect such location to determine its suitability. The location from which the sod is to be obtained shall be approved by the engineer before the sod is dug. Mulch sod supplied shall predominate in Bermuda roots and be reasonably free of weeds. Should the engineer direct, the contractor shall mow all areas from which the sod is to be obtained before digging same. The mulch sod shall be furnished by the contractor and may be dug by machine or hand methods, loaded and unloaded in bulk.

Broadcast Sodding shall consist of Bermuda roots and tops, either "bare-rooted" or containing a small amount of soil attached to the roots, which shall be kept moist during digging, transplanting and spreading.

Topsoil shall consist of good loamy topsoil from fields, woods, creek banks or other approved sources. Such top-

soil shall be removed only from the upper 6 inch stratum unless deeper digging is permitted by the engineer. Topsoil shall only be removed from locations approved by the engineer. The topsoil shall be free of tree and shrub roots, stumps, rocks, weeds, trash and other debris and the contractor may be required to mow, clear and grub, and otherwise clean up a source area of topsoil, if directed by the engineer. The topsoil may or may not contain Bermuda roots and tops, or other approved grasses.

CONSTRUCTION METHODS

9.05 General:

After the roadway has been completed in accordance with the plans and specifications, it shall be sodded at locations shown on the plans or as directed by the engineer. The areas to be sodded shall be surface dressed by machine method in accordance with Article 12.03, Part 1, Division II. On all areas on which machine work is impracticable, such areas shall be surface dressed by hand method in accordance with Article 12.04, Part 1, Division II. The areas to be sodded shall be in a thoroughly pulverized condition to a depth of approximately 3 inches. After scarifying, the surface shall be leveled by dragging, the whole object being to place such surfaces in a loose, pulverized condition conforming to the required grades. Fills and other areas which are sufficiently pulverized may be eliminated at the discretion of the engineer.

Unless otherwise indicated on the plans or directed by the engineer, the areas to be sodded shall begin at the outside edges of the surface or base course or edge of roadbed on grading projects and shall extend laterally for the required width of sodding. Sodding shall be done at such times as directed by the engineer and in such manner that the grass shall take root. Sod shall be watered if and when directed by the engineer.

The contractor will be required to replace any sod which is unsatisfactory and all sod shall be alive and growing at the time of final acceptance.

The contractor shall have adequate water tanks and other watering equipment and supply of water available when beginning sodding operations and shall keep same available throughout such operations and until final acceptance of the project. Sodding operations shall not begin until such equipment and supply acceptable to the engi-

neer is on hand and ready for use as directed by the engineer.

Topsoil shall be furnished and placed on the scarified surface when required by the plans.

Fertilizer shall be furnished and placed when an item for this work is included in the contract, as provided in Section 11, Part 1, Division II.

9.06 Sodding:

(a) Sprig Sodding, Tuft Sodding and/or Slab Sodding: All sod under these items shall be cut to a minimum depth of 2½ inches with acceptable sod cutters or with sharp, flat shovels or spades. After cutting in the field, and within 48 hours, the sod shall be placed flat, grass side up on boards of convenient length and acceptable to the engineer, and hauled to the project with the soil intact. Only one layer of sod shall be placed on each board and such boards shall be of sufficient thickness to prevent bending and of sufficient width that the slabs of sod shall not hang over the edges. The sod slabs shall be placed closely without leaving spaces between them. In no case shall sprig sodding, tuft sodding or slab sodding be loaded in bulk on vehicles or dumped in bulk on the planting site.

Sprig sodding or tuft sodding may be cut in larger pieces at the source, loaded on boards as such, and cut to the proper size and length at the planting site. Since it is necessary to handle sprig and tuft sodding principally by hand, picking it up from the boards to plant, the contractor is cautioned to exercise care to insure that no more soil is lost from the grass roots than is unavoidable. In tuft sodding the lengths of strips shall be of convenient length for handling, acceptable to the engineer. The sprig sodding and tuft sodding shall not be totally covered with soil and a sufficient amount of grass tops shall be left uncovered to insure quick growth. If an item for fertilizer is included in the contract for sprig sodding or tuft sodding, the fertilizer shall be placed directly in the planting furrows or holes.

In cutting sod for slab sodding, the strips shall be cut uniformly 12 inches wide for close and uniform planting. The lengths of this sod shall be cut for convenient handling acceptable to the engineer. Upon delivery at the planting site, slab sodding shall be planted directly from the boards onto the surface soil by tilting the board slightly, jamming

the edges of the sod on the board against the edges of sod already in place and then slipping the board from underneath the sod. Slabs of sod which do not contact closely shall be pulled together with rakes, hoes or other suitable tools. In no case shall slab sodding be removed from the boards and handled by hand, except to use as fillers of small cracks or at locations where it would be impracticable to place the sod by direct board method as described. The placing of slab sodding on hard pans, slicked or hard packed areas, where it would slide or where the grass roots would be delayed in taking hold in the natural soil, will not be permitted. All areas to receive slab sodding shall be thoroughly scarified and pulverized and then dressed to grade as hereinbefore provided. If an item for fertilizer is included in the contract for slab sodding it shall be broadcast over the entire area to receive the sodding.

All planting of sprig sodding, tuft sodding or slab sodding shall be rolled as soon after planting as practicable with the use of plain rollers, cultipackers or soil pulverizers. In case rolling is impracticable, the contractor shall use hand methods of tamping the sod into place, suitable to the engineer.

(b) Mulch Sodding: Mulch sod shall be dug as hereinbefore provided. In addition the contractor shall thoroughly disk the area from which the mulch sod is to be obtained. He may then plow up in rows, blade into windrows or otherwise pile up the sod for convenience in loading; however, he shall not disk, plow, windrow or otherwise stock pile the sod on any source area too large for early removal and use, and shall load, haul and spread on the areas to receive sodding all such stock piled sod within 48 hours after stock piling same. Mulch sod shall not be contaminated with tree and shrub roots, tops, branches or other debris and such foreign material shall be dug up, cleared and removed from the source area before beginning the disking of the area and the removal of the mulch sod.

The mulch sod shall be placed and spread over all areas to be mulch sodded to a depth of 4 inches or less, as directed by the engineer. The placing of such sod on hard pans, slicked or hard packed areas where it would slide or the roots would be delayed in taking hold in the natural surface soil, will not be allowed. All areas to receive mulch sodding shall be thoroughly scarified and pulverized and then dressed

to grade as hereinbefore provided. If an item for fertilizer is included in the contract for mulch sodding, it shall be broadcast over the entire area to receive mulch sodding. After placing and spreading the sod it shall be rolled with a cultipacker or soil pulverizer until the surface presents a level appearance. In inaccessible places and locations where rolling with the above required equipment is impracticable, the contractor shall hand tamp such sod into place in a manner satisfactory to the engineer. After mulch sod has been dumped on the site, the spreading of same shall be done in a manner which will not tear up and leave an excess of grass roots on the surface which would be exposed. Spreading may be done directly from the trucks if suitable to the engineer. The manner of spreading shall be agreed upon by the engineer but in no case shall spike tooth harrows, drags with spikes or other similar tools be permitted.

(c) Broadcast Sodding: Bermuda roots and tops shall be broadcast over all areas to be sodded. The roots and tops shall be placed closely together on the surface so as to fully cover the ground and so that no spaces will be left between individual clumps of roots and tops. All Bermuda roots and tops shall be kept moist from the time of digging to that of spreading on the areas requiring sodding. All dried out roots and tops will be rejected. Spreading shall not be done over any area which is too large to be immediately disked.

Immediately after spreading, the Bermuda roots and tops shall be thoroughly disked into the surface so they will be chopped and covered without disturbing the uniform distribution.

After disking, the areas thus sodded shall be dragged if necessary, and then rolled with a cultipacker or soil pulverizer until the surface presents a level appearance. In inaccessible places and locations where rolling with the above required equipment is impracticable, the contractor shall hand tamp such areas in a manner satisfactory to the engineer. Toothed harrows, rakes, drags with spikes, and other implements which would tend to tear out the grass roots and tops shall not be used to spread or level any areas after the broadcasting of the Bermuda roots and tops.

If an item for fertilizer is included in the contract for broadcast sodding, it shall be broadcast over the entire area prior to broadcasting the Bermuda roots and tops.

(d) Topsoil: When the furnishing of topsoil is required by the plans, it shall be placed on the specified areas and spread by means of bulldozers, blades, and drags and in inaccessible places by hand methods, to the section indicated on the plans or directed by the engineer. The topsoil shall then be thoroughly disked as directed by the engineer. After spreading and disking, all stiff clods, lumps, stones, roots, litter or other foreign matter shall be raked and removed from the area. Prior to placing and spreading the topsoil on any area, such area shall have the approval of the engineer. The placing of topsoil on hardpans, slicked or hard surfaces will not be permitted. All areas to receive topsoil shall be thoroughly scarified and pulverized and then dressed to grade as hereinbefore provided.

MEASUREMENT AND PAYMENT

9.07 Method of Measurement:

Sprig Sodding, Tuft Sodding, Slab Sodding and/or Broadcast Sodding will be measured by the square yard and the area to be included in the measurement shall be the actual area sodded and accepted by the engineer.

Mulch Sod and/or Topsoil will be measured by the cubic yard in vehicles at the point of delivery on the project as specified under Article 9.01, Division I.

Watering will be measured by the 1,000 gallons of water actually used and shall be measured in the watering tanks or other watering equipment used on the project.

When a pay item for surface dressing is included in the contract, measurement of surface dressing will be made as specified in Article 12.05, Part 1, Division II.

Measurement of Fertilizer will be by the pound for commercial fertilizer or by the cubic yard for domestic fertilizer as specified in Article 11.06, Part 1, Division II.

9.08 Basis of Payment:

Sod planted and accepted, measured as provided above, shall be paid for at the contract price per unit for "Sodding" which price and payment shall constitute full compensation for all surface dressing (except when surface dressing is included as a pay item in the contract); for furnishing, hauling, planting, rolling and maintaining the sod; and for the furnishing of all equipment, tools, labor and incidentals

and the performance of all work necessary to complete the item.

Topsoil complete in place and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Topsoil," which price and payment shall constitute full compensation for all surface dressing (except when surface dressing is included as a pay item in the contract); for furnishing, hauling, placing, spreading and disking the topsoil; and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Watering, measured as provided hereinbefore, shall be paid for at the contract price per 1,000 gallons for "Watering" which price and payment shall constitute full compensation for furnishing the water, for all tools, labor, equipment and incidentals and the performance of all work necessary to complete the item.

When a pay item for surface dressing is included in the contract, payment for surface dressing will be made as provided under Article 12.06, Part 1, Division II.

Fertilizer will be paid for as provided in Article 11.07, Part 1, Division II.

Payment will be made under:

Item 1-9-1, Sprig Sodding, per square yard.
Item 1-9-2, Tuft Sodding, per square yard.
Item 1-9-3, Slab Sodding, per square yard.
Item 1-9-4, Mulch Sodding, per cubic yard.
Item 1-9-5, Broadcast Sodding, per square yard.
Item 1-9-6, Topsoil, per cubic yard.
Item 1-9-7, Watering, per one thousand gallons.

SECTION 10

SEEDING

10.01 Description:

This item shall consist of the preparation of seed bed and furnishing and sowing grass seed on the areas designated on the plans or in the proposal, all in accordance with these specifications and as directed by the engineer.

MATERIALS

10.02 Seed:

All seed furnished shall conform to all requirements, rules and regulations of Chapter 11, 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 I, herein.

Each variety of seed shall be furnished and delivered in separate bags or other containers. Each bag or container shall bear the tag of the Louisiana Seed Commission showing purity, germination, noxious weed content and other analyses.

All seed furnished shall be of 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 I

Variety of Seed	Minimum Percentage of Pure Live Seed (Purity times germination including hard seed)	Maximum Percentage of Weed Seed Permitted
Hulled Bermuda	86	1
Carpet Grass	76	2
Louisiana White Dutch Clover	86	1
Dixie Crimson Clover	86	1
Common Lespedeza	76	2.5
Kobe Lespedeza	80	2.5
Alta Fescue	86	1
Kentucky 31 Fescue	86	1

TABLE II

Variety	Soil Areas in Which to Plant					Lbs. Per Acre	Preferable Time to Plant
	(1)	(2)	(3)	(4)	(5)		
Hulled Bermuda	×	×	×	×	×	15	Feb. 15 thru Oct.
Carpet Grass	....	....	×	×	....	25	Feb. 15 thru Oct.
La. White Dutch Clover	×	×	×	×	×	15	Aug. thru Nov., Feb. and Mar.
Dixie Crimson Clover	×	×	×	×	×	30	Aug. thru Nov., Feb. and Mar.
Common Lespedeza or Kobe Lespedeza	....	×	×	×	×	30	Feb. thru April
Alta Fescue or Kentucky 31 Fescue	×	×	×	×	×	30	Aug. thru Nov.

TABLE III

Mixture	Varieties of Seed to Mix	Lbs. Per Acre	Time to Plant	Preferable Soil Areas in Which to Plant
A	Hulled Bermuda Carpet Grass	10 20 30	Feb. 15 thru Oct.	(3), (4); and (2), (5) if Carpet Grass is native.
B	Hulled Bermuda CommonLespedeza or Kobe Lespedeza	10 20 30	Feb. thru April	(2), (5); and parts of (1) if Lespedeza is native.
C	Hulled Bermuda Carpet Grass Common Lespedeza or Kobe Lespedeza	6 10 14 30	Feb. 15 thru April	(3), (4); and (2), (5) if Carpet Grass is native
D	Hulled Bermuda La. White Dutch Clover Carpet Grass	8 8 14 30	Aug. thru Oct. Feb. 15 thru Apr.	(3), (4); and (2), (5) if Carpet Grass is native
E	Hulled Bermuda Dixie Crimson Clover Carpet Grass	8 12 10 30	Aug. thru Oct. Feb 15 thru Apr.	(3), (4); and (2), (5) if Carpet Grass is native.
F	Hulled Bermuda La. White Dutch Clover	10 10 20	Aug. thru Oct. Feb 15 thru Mar.	(1), (2), (5)
G	Hulled Bermuda Dixie Crimson Clover	10 20 30	Aug. thru Oct. Feb. 15 thru Mar.	(1), (2), (5)

TABLE III—Continued

Mixture	Varieties of Seed to Mix	Lbs. Per Acre	Time to Plant	Preferable Soil Areas in Which to Plant
H	Hulled Bermuda Alta Fescue or Kentucky 31 Fescue	10 20 30	Aug. thru Oct.	(1), (2), (5)
I	Hulled Bermuda Carpet Grass Alta Fescue or Kentucky 31 Fescue	6 10 14 30	Aug. thru Oct.	(3), (4); and (2), (5) if Carpet Grass is native.

10.03 Sampling and Testing:

Samples of each variety of seed shall be furnished for analysis and testing when and if directed by the engineer.

10.04 Selection of Seed:

Prior to planting time, the engineer shall select one variety of seed as shown in Table II, or a combination mixture of varieties as shown in Table III. The contractor shall abide by such selection and furnish seed in accordance therewith.

Seed shall be selected for planting on the basis of the 5 general soil areas or subdivisions of the State 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 and northern part of State.)

(4) Coastal Prairie Soils.

(5) Ouachita Valley Cone. (Lying between the Ouachita River Bottom on the west and Boeuf River Bottom on the east.)

A single variety of seed or a combination mixture in the quantities indicated may be sown in the 5 general soil areas as shown in Table II and Table III respectively and shall be sown during planting season shown therein, unless otherwise permitted by the engineer.

CONSTRUCTION METHODS

10.05 Areas to be Seeded:

The areas to be seeded will generally consist of areas which are bare of grass and areas on which some grass is already growing.

10.06 Preparation of Seed Bed (Bare Areas):

The seed bed shall be prepared by breaking, disking, harrowing, blading, dragging or other approved methods. The soil shall be thoroughly pulverized to a minimum depth of approximately 3 inches and leveled as directed by the engineer. The surface soil shall be firmed by lightly rolling the area with a cultipacker. If natural firming by rain has occurred, the rolling may be eliminated. All sticks, debris, and other foreign matter must be removed and the soil left in a suitable horticultural condition to receive the seed. If top soil, humus, fertilizer or other material is required by the specific items of the contract, they shall be spread over the areas and incorporated into the surface soil during the preparation of the seed bed. The seed shall be mulched with hay, straw, or litter, if specified on the plans or in the special provisions.

10.07 Preparation of Seed Bed (Grassy Areas):

Areas partly covered with grass, but on which seed is to be sown to augment the grass growth, will be lightly disked or lightly scarified. Disking and scarifying shall continue until small washes are filled and the seed bed is pulverized, care being taken not to unduly disturb the existing grass. After disking, the area shall be lightly rolled with a cultipacker. The amount of disking or scarifying will depend on the condition of the existing grass and the extent of such disking shall be as directed by the engineer. If top soil, humus, fertilizer or other material is required by specific items of the contract, they shall be spread over the areas and incorporated into the surface soil during the preparation

of the seed bed. The seed shall be mulched with hay, straw, or litter, if specified on the plans or in the special provisions.

10.08 Seeding:

Immediately prior to planting, all clovers and lespedezas shall be inoculated with the proper culture for each variety of seed. If the seed is not planted on the date of inoculation, the inoculation shall be repeated.

All seed shall be planted in the proper season and in the amounts shown in Tables II and III unless written permission is granted by the engineer for earlier or later plantings. Seed shall be sown with rotary or other mechanical seeders. All seeded areas shall be lightly rolled immediately after seeding so as to press the seed firmly into the soil to prevent drifting or washing, unless sufficient natural firming by rain has occurred.

After seed has been planted, seeded areas shall be watered with approved watering tanks or other watering equipment, unless, in the opinion of the engineer, there is sufficient rainfall to eliminate the necessity for watering. The seeded areas shall be watered immediately following the sowing of the seed, and the second and third watering shall follow the first watering at 48 hour intervals. Following the third watering, if all other items of the contract have been satisfactorily completed, the project will be finally accepted and the contractor relieved of further responsibility except for the seeding item on which he will be required to continue the watering as directed by the engineer for a period of 3 weeks from the date of planting.

MEASUREMENT AND PAYMENT

10.09 Method of Measurement:

Seeding will be measured by the pound and the number of pounds of seed sowed shall be measured. For the purposes of measurement, no differentiation will be made for different types or combination of types of seed furnished.

Watering will be measured as provided in Article 9.07, Part 1, Division II.

10.10 Basis of Payment:

The number of pounds of seed sowed and accepted, measured as provided above, shall be paid for at the con-

tract unit price per pound for "Seeding," which price and payment shall constitute full compensation for furnishing all materials (except top soil, humus, fertilizer, or other material covered by specific items of the contract), equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Watering will be paid for as provided in Article 9.08, Part 1, Division II.

Payment will be made under:

Item 1-10-1, Seeding, per pound.

SECTION 11

FERTILIZER

11.01 Description:

This item shall consist of furnishing and applying fertilizer at the locations indicated on the plans in accordance with these specifications and as directed by the engineer.

MATERIALS

11.02 Fertilizer:

Commercial fertilizer shall conform to the requirements of the Louisiana Department of Agriculture, Fertilizer Division. Domestic fertilizer, such as manure, shall be approved by the engineer.

CONSTRUCTION METHODS

11.03 Fertilizing Broadcast:

The amount and kind of fertilizer to be used will be shown on the plans or in the special provisions. Fertilizer shall be uniformly broadcast over the area to be fertilized either by hand or machine methods. Unless otherwise indicated in the special provisions, commercial fertilizer shall be broadcast at the rate of approixmately 800 pounds per acre.

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 surface dressing is being done by hand, it may be applied just before final raking and leveling.

If fertilizer is broadcast for the purpose of increasing existing grass growth, it must be evenly scattered over the grass and thoroughly wet down with water as directed by the engineer.

11.04 Fertilizing Sodding:

When fertilizing of sod under Section 9, Part 1, Division II is required, the fertilizer shall be applied between the tufts or sprigs or broadcast over the slabs of sod in the amount as provided for under Article 11.03 hereinbefore, and as directed by the engineer. Where required, the area fertilized shall be thoroughly watered.

11.05 Fertilizing Existing Trees:

A circle of holes 3 to 4 feet apart shall be drilled in the soil under the outer edge of the branches called the "drip." Another circle of holes shall be made inside the first circle a distance of 3 to 4 feet inside of the first circle. The holes in the inner circle shall not be placed opposite the holes in the outer circle, but shall be staggered or alternated. All holes shall be from 12 to 18 inches deep and approximately 2½ to 3 inches in diameter. The holes may be made by driving an iron bar, pipe or other suitable sharp instrument in the ground and twisting same or they may be made with a soil auger suitable for the purpose. Spades, shovels or other large tools shall not be used for making the holes. After the holes are made, the required amount of fertilizer is to be placed in each hole and the remainder of the hole filled with suitable soil and the filling watered down.

MEASUREMENT AND PAYMENT

11.06 Method of Measurement:

Commercial fertilizer will be measured by the pound and the number of pounds of fertilizer actually used shall be measured.

Domestic fertilizer will be measured by the cubic yard in vehicles at the point of delivery on the project as specified under Article 9.01, Division I.

11.07 Basis of Payment:

The number of units of fertilizer placed and accepted, measured as provided above, shall be paid for at the con-

tract unit price per unit for "Fertilizer," complete in place, which price and payment shall constitute full compensation for furnishing all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-11-1, Fertilizing (Commercial Fertilizer), per pound.

Item 1-11-2, Fertilizing (Domestic Fertilizer), per cubic yard.

SECTION 12

SURFACE DRESSING

12.01 Description:

This item shall consist of the conditioning of the ground surface to put such surface in an excellent horticultural condition for sodding, seeding or planting trees and other plants. In general, it shall follow the grading work and shall include all areas indicated on the plans and by the special provisions or areas designated by the engineer all in accordance with the plans and these specifications.

CONSTRUCTION METHODS

12.02 Surface Dressing Methods:

Surface dressing shall be done by machine or hand methods or a combination of both as indicated on the plans or directed by the engineer.

12.03 Machine Method:

All hard pan areas, where practicable and necessary, shall be plowed, disked, cross-disked, harrowed, bladed or dragged as designated by the engineer so that the surface soil will be left up to grade in a smooth and thoroughly pulverized condition acceptable to the engineer. On any part of a previously graded area, where the surface is loose to a depth of approximately 3 inches, it will not be necessary to plow same when disking will accomplish the purpose, but where a hard pan occurs on the graded surface, such areas must be plowed if and when directed by the engineer.

Where corners, borders, fences, sides of ditches, canals or any other obstruction occurs, the contractor will be required to disk same by hand methods if disking by machine method is considered impracticable by the engineer. The final blading, dragging and smoothing of the surface shall be done so as to leave the surface up to specified grade. All sticks, clumps of grass, roots, stones and large clods which cannot be broken up easily and any other material or debris which is detrimental to a smooth or well prepared surface shall be removed from the project and satisfactorily disposed of as directed by the engineer.

12.04 Hand Method:

All hard pan areas shall be spaded and thoroughly pulverized by the use of hand tools, such as hoes, and rakes. Rakes shall be used to dress the surface to the required grade and the ground surface shall be left in a horticultural condition satisfactory to the engineer. The areas dressed shall be cleared of all debris as specified in Article 12.03.

MEASUREMENT AND PAYMENT

12.05 Method of Measurement:

Measurement of surface dressing will be made by the square yard or acre. The particular method of measurement to be used shall be as indicated on the plans or in the contract. The area of surface dressing shall be determined by measurement of the area actually dressed.

12.06 Basis of Payment:

The number of units dressed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Surface Dressing," which price and payment shall constitute full compensation for furnishing all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 1-12-1, Surface Dressing (Machine Method), per square yard.

Item 1-12-2, Surface Dressing (Machine Method), per acre.

Item 1-12-3, Surface Dressing (Hand Method), per square yard.

DIVISION II

Part 2—Base Courses

INDEX

PART 2—DIVISION II

SECTION 1

RECONSTRUCTED BASE COURSE

1.01 Description:

This item shall consist of the reshaping of an existing surface and the addition of new material if required, all of which shall be compacted to form a foundation course for other base courses or for surface courses or pavement. Reconstructed base courses shall be constructed at the locations indicated on the plans, or as otherwise directed, and shall be constructed in accordance with these specifications, and in conformity with the lines, grades and typical cross sections shown on the plans.

1.02 Materials:

New materials required in the reconstruction of the base course will be indicated on the plans or in the special provisions. They shall conform to the specifications for the respective materials set forth under "Materials" in Sections 2 and 6, Part 2, Division II of these specifications.

1.03 Construction Methods:

The existing surface shall be scarified for the full width of the proposed base course, and to such depth below

the proposed finished surface as will eliminate all depressions and irregularities and permit of uniform shaping. Where the existing surface course is to be widened and where grade changes are indicated, the scarified material shall be windrowed or otherwise salvaged, as directed by the engineer, and the necessary excavation or filling performed to permit the construction of a base course of the thickness and width indicated on the plans. Any material excavated containing satisfactory metal or binder shall be incorporated in the base course.

The existing material shall be shaped to conform to the required section and new material added. The new and old material shall be thoroughly mixed by plowing, harrowing, blading or other approved methods.

All other operations under this item shall be performed in accordance with the requirements set forth under "Construction Methods," Articles 2.12 to 2.19, inclusive, or Articles 6.04 to 6.08, inclusive, as the case may be, of Part 2, Division II.

MEASUREMENT AND PAYMENT

1.04 Method of Measurement:

Reconstructed base course will be measured by the square yard. The width of reconstructed base course to be paid for shall be the total width of base course indicated on the plans, or ordered by the engineer, and the length shall be the actual center line length measured along the surface.

New materials will be measured as provided under Article 2.20, or Article 4.09, or Article 6.09, Part 2, Division II, as the case may be. Excavation will be measured as provided under Article 4.14, Part 1, Division II.

1.05 Basis of Payment:

Reconstructed base course completed and accepted, measured as provided above, shall be paid for at the contract unit price per square yard for "Reconstructed Base Course," which price and payment shall constitute full compensation for scarifying, mixing, spreading, sprinkling with water, rolling, machining, dragging and all other work as provided herein; the furnishing of all tools, labor, equipment and incidentals and the performance of all work necessary to complete the item.

New materials will be paid for as provided under Article 2.21, or Article 4.10, or Article 6.10, Part 2, Division II, as the case may be. Excavation will be paid for as provided under Article 4.15, Part 1, Division II.

Payment will be made under:

Item 2-1-1, Reconstructed Base Course, per square yard.

SECTION 2

AGGREGATE TYPE BASE COURSE

Crushed Stone Base Course
Washed Gravel Base Course
Washed Sand Gravel Base Course
Sand Clay Gravel Base Course
Iron Ore Base Course
Clam Shell Base Course
Reef Shell Base Course
Clam and Reef Shell Base Course

2.01 Description:

This item shall consist of a foundation course for the surface course or pavement. The base shall be composed of the type of base material shown on the plans and shall be constructed on the prepared subgrade or reconstructed base course in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross sections shown on the plans.

2.02 Equipment:

All equipment for the proper construction of the base shall be on the project, in satisfactory working condition, and shall have been approved by the engineer before construction begins.

Blade Grader: The blade grader shall weigh not less than 8 tons and shall have a blade at least 10 feet in length and a wheelbase of not less than 15 feet.

Rollers: Rollers may be any approved type or combination of types that will obtain the required compaction.

Brooms: If the base course is constructed of crushed stone, brooms shall be furnished consisting of fiber hand brooms and a fiber broom rigidly coupled to the roller. This latter broom shall be at least as long as the full width

of the roller and shall be so attached to the roller that it may be raised when not in use.

Watering Equipment: Provision shall be made by the contractor for furnishing water at the site of the work in sufficient quantities to moisten the base material to obtain the desired compaction. Water wagons or other approved sprinkling devices shall be provided.

MATERIALS

2.03 Crushed Stone:

Crushed stone shall consist of fragments of hard, durable particles of stone, excluding schist, shale or slate, and containing not more than 5 per cent of soft, friable material and not more than 5 per cent of flat or elongated pieces. The stone shall be furnished and delivered to the site of the work in 3 separate sizes conforming to the following gradation when tested by means of laboratory sieves:

Sieve	Per Cent Passing		
	Size 1 Choke	Size 2 Coarse	Size 3 Screenings
2½"	.....	95 to 100	.....
1½"	.....	30 to 65	.....
¾"	.....	2 to 10	.....
⅝"	80 to 95	.....	.....
½"	.....	.....	100
No. 4	2 to 10	.....	75 to 95
No. 100	.....	.....	5 to 15

Sand may be substituted for stone screenings.

2.04 Washed Gravel:

Washed or screened gravel shall consist of hard, durable particles of stone uniformly graded in size from coarse to fine, and when tested by means of laboratory sieves, shall meet the following requirements:

Sieve	Per Cent Passing
1½"	95 to 100
¾"	60 to 95
No. 4	0 to 15
No. 4 (Foreign matter)	0 to 2

2.05 Washed Sand Gravel:

Washed or screened sand gravel shall consist of clean, hard, durable particles of stone uniformly graded in size from coarse to fine, and when tested by means of laboratory sieves, shall meet the following requirements:

Sieve	Per Cent Passing
1½"	95 to 100
No. 4	25 to 40
No. 100	0 to 8
Clay (by Elutriation)	0 to 3%

2.06 Sand Clay Gravel:

Sand clay gravel shall be composed of either a natural mixture of sand, clay and gravel, or an artificial mixture prepared by either the mixing of washed sand gravel and binder; washed gravel or crushed stone, sand and binder; or by the addition of washed gravel or crushed stone to natural sand clay gravel. The mixture shall not contain more than 5 per cent of mica, feldspar and schist, and shall be free from vegetable or other injurious matter.

When tested by means of laboratory sieves, the combined materials shall meet the following requirements:

Sieve	Per Cent Passing	
	Grade A	Grade B
1½"	95 to 100	95 to 100
¾"	75 to 95	.....
No. 4	40 to 60	50 to 75
No. 10	25 to 45	35 to 50
No. 40	20 to 40	20 to 40
No. 200	10 to 20	12 to 25

The particular grade to be used shall be as shown on the plans or as stated in the special provisions.

The fraction passing the No. 40 sieve, when tested by the Method of Dry Preparation of Disturbed Soil Samples

for Test, A.A.S.H.O. Designation: T 87, shall meet the following physical characteristics:

Liquid Limit (Maximum)	25
Plastic Index	0 to 6

As a matter of information, but not limitation, the contractor is advised that the several materials may be combined in approximately the following proportions:

	Grade A	Grade B
Gravel or Crushed Stone	45%	35%
Sand	40%	47½%
Binder	15%	17½%

However, the exact proportion shall be determined in the laboratory from test samples from materials furnished by the contractor.

Washed gravel used in preparing an artificial mixture shall conform to the requirements of Article 2.04.

Washed sand gravel used in preparing an artificial mixture shall conform to the requirements of Article 2.05.

Crushed stone used in preparing an artificial mixture shall conform to the requirements for same contained in Article 1.03, Part 3, Division II, except that the test for hardness will not be required.

2.07 Iron Ore:

The iron ore shall consist of ferruginous sandy or gravelly material and shall be composed of either a natural iron ore or an artificially prepared mixture consisting of natural iron ore and washed gravel or crushed stone. The mixture shall not contain more than 5 per cent of mica, feldspar and schist, and shall be free from vegetable or other injurious matter.

When tested by means of laboratory sieves, the material shall meet the following gradation requirements:

Sieve	Per Cent Passing	
	Grade A	Grade B
1½"	95 to 100	95 to 100
No. 4	40 to 60	50 to 75
No. 10	35 to 55	35 to 50
No. 200	10 min.	12 min.

The particular grade to be used shall be as shown on the plans or as stated in the special provisions.

Gravel or hard pieces of ore over 2 inches in its largest dimension will not be permitted.

That fraction of the material passing the 1½ inch sieve and retained on No. 4 sieve shall be uniformly graded from coarse to fine.

The fraction passing the No. 40 sieve, when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87, shall meet the following physical characteristics:

Liquid Limit (Maximum)	25
Plastic Index	0 to 6

Washed gravel used in preparing an artificial mixture shall conform to the requirements of Article 2.04.

Crushed stone used in preparing an artificial mixture shall conform to the requirements for same contained in Article 1.03, Part 3, Division II, except that the test for hardness will not be required.

The quantity of washed gravel or crushed stone, as the case may be, to be added to the local iron ore shall be determined in the laboratory.

2.08 Clam Shell:

The shell shall consist of dead clam shell. A rotary type screen washer shall be used for washing the shell, the mesh of which shall not be smaller than ¼ inch. The foreign

matter content, as determined by washing, shall not exceed 10 per cent by weight when dry.

2.09 Reef Shell:

The shell shall consist of dead oyster shell and shall not contain cannery or live shell. A rotary type screen washer shall be used for washing the shell, the mesh of which shall not be smaller than ¼ inch. The foreign matter content, as determined by washing, shall not exceed 10 per cent by weight when dry.

2.10 Clam and Reef Shell:

Shell shall consist of either a natural or artificially prepared mixture of dead clam and dead reef shell. The shell shall be free from objectionable matter such as sticks, mud, clay lumps or other foreign materials. However, foreign matter such as clay and sand will be permitted in an amount not exceeding 10 per cent by weight when dry, provided such material is dispersed throughout the mass and provided also that the plasticity index of the completed mix shall not exceed 6 and the liquid limit shall not exceed 24.

The shell base shall be composed of a mixture of 65 per cent clam and 35 per cent reef shell by volume. A tolerance of plus or minus 5 per cent will be permitted. In the event that a natural mixture of clam shell and reef shell is used, any variations of the mixture outside the above limits shall be corrected by the addition of clam or reef shell, as the case may be, meeting the respective requirements of Articles 2.08 and 2.09.

The quantity of clam shell or reef shell, as the case may be, to be added to the natural mixture shall be determined in the laboratory.

2.11 Special Binder:

Special Binder shall meet the following requirements:

Sieve	Per Cent Passing
No. 10	90 to 100
No. 40	70 to 100

Special Binder, when mixed with sand in the base course in the amount specified on the plans or specified by the engineer, shall, when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87, conform to the following physical characteristics:

Liquid Limit (Maximum)	25
Plastic Index	0 to 6

CONSTRUCTION METHODS

2.12 Subgrade:

The subgrade shall be prepared as provided under Article 4.12, Part 1, Division II.

2.13 Forms:

Unless otherwise provided on the plans or in the special provisions, the use of forms will not be required.

When forms are required by the plans or special provisions they shall conform to the following requirements:

Metal or wood forms may be used. Wood forms shall be of at least 2-inch lumber, square edged and sound, and of sufficient width to extend from top to bottom of loose spread base material. Forms shall be set true to line and grade and substantially staked in place to insure stability during spreading and rolling operations.

The earth shoulders shall be constructed to full width and height as the forms are removed.

2.14 Transporting and Spreading Base Material:

(a) Crushed Stone Base Course: The base material shall be transported in approved vehicles and uniformly spread in the amounts indicated on the plans or directed by the engineer. The material may be spread by the use of power spreaders or trucks equipped to distribute the material, or by other approved methods.

The material shall be spread over the prepared subgrade in 3 separate courses consisting of screenings, coarse stone, and choke stone, and in that order. The screenings shall be spread at the rate of 50 pounds per square yard. The coarse stone shall be spread in one or more layers. A

layer shall have a maximum thickness, loose, of 5 inches. The voids in each layer of coarse stone shall be filled with the choke material. The choke material shall be applied in 2 or more applications and never in such quantities, at any time, as will cause caking or bridging of unfilled voids or prevent direct bearing of the roller on the coarse stone.

(b) Other Types of Aggregate Base Courses: For other types of bases where the total loose depth of material to be compacted is 5 inches or more, it shall be spread and compacted in 2 or more courses of equal depth, the maximum loose depth of each course being not more than 5 inches.

The base material in the first course may be dumped directly on the prepared subgrade, but it shall be uniformly distributed over the subgrade either by hand or from approved spreader boxes or other mechanical equipment. In the use of mechanical equipment for spreading material, dump piles shall be so spread as to insure uniform compaction of the material.

(c) General: During the dumping, spreading and compacting operations the amount of moisture in the base material shall be controlled so as to obtain the maximum compaction of the material. The engineer shall determine the proper moisture content of the base material. The contractor shall be responsible for the uniform unloading and distribution of the required amount of material throughout the length of each 100-foot station.

The contractor will be required to maintain the base free from ruts and irregularities at all times during the construction of the base.

2.15 Mixing:

(a) Crushed Stone Base Course: Blade mixing of the various sizes of crushed stone comprising the base course will not be required.

(b) Washed Gravel Base Course or Washed Sand Gravel Base Course: When the base course requires binder material as provided by the plans, the combination of materials shall be mixed as hereinafter provided. The proportions of the materials incorporated and used in the base shall be as shown on the plans or in the special provisions and as directed by the engineer. In any event the several ingredients shall be in such proportions that the base can

be set up and compacted to the satisfaction of the engineer. After all materials have been placed, the various types shall be thoroughly mixed to the full depth of the layer by approved machine methods. Traveling mixers and traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. However, the depth of combined materials placed in any one layer shall not exceed the requirements of Article 2.14 (b). Mixing shall continue until the entire surface is free from lumps or pockets of binder or other material and the engineer is satisfied that the materials are uniformly distributed throughout the mass. As soon as mixing of each course is completed to the satisfaction of the engineer, the surface shall be shaped to conform with the typical section and compacted.

When the use of roadside binder is indicated on the plans, suitable approved material will be obtained from the excavation and incorporated in the base course as herein provided. When the use of Special Binder is indicated on the plans, material meeting the specifications for Special Binder shall be furnished by the contractor and incorporated in the base course as herein provided.

(c) Sand Clay Gravel Base Course or Iron Ore Base Course: In the event the several materials are placed separately upon the prepared subgrade, each type of material shall be spread uniformly over the full width of the base course. After all the materials have been placed, the various types shall then be mixed to the full depth of the layer by approved machine methods. Traveling mixers and traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. However, the depth of combined materials placed in any one layer shall not exceed the requirements of Article 2.14 (b). Mixing shall continue until each type of material entering into the base course is uniformly distributed throughout the mass.

When the base course materials consist of a natural mixture or an artificial mixture that has been mixed prior to placing upon the roadbed, the material shall be machine mixed in accordance with the above paragraph if the several materials are not uniformly distributed throughout the mass. The engineer shall be the sole judge as to the uniformity of the mix.

When the several ingredients of the combined mix specified above are mixed, there will be a reduction due to

shrinkage loss in mixing. The percentage of this shrinkage loss will vary according to the gradation of the several materials furnished and the contractor is hereby notified that the said shrinkage loss for the several materials furnished will be determined in the laboratory.

Material shall be watered during mixing operations, when and if directed by the engineer. When uniform, the mixture shall be spread evenly to the cross section shown on the plans.

(d) Clam Shell, Reef Shell, or Clam and Reef Shell: After each course of base material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. However, the depth of materials placed in any one layer shall not exceed the requirements of Article 2.14 (b). Traveling mixers and traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall again be spread evenly to the typical cross section shown on the plans.

2.16 Compacting:

(a) Crushed Stone Base Course: The course constructed of screenings shall be moistened and rolled to a smooth surface.

Each layer of the course constructed of coarse stone shall be thoroughly rolled in the dry. The rolling shall begin at the sides and progress toward the center, parallel to the center line of the roadway, uniformly lapping each preceding track by ½ of the width of the roller. On superelevated curves, the rolling shall begin at the low side and progress toward the high side. The rolling shall continue until the entire surface has been thoroughly compacted and mechanically bonded and until there is no perceptible disturbance of the stone ahead of the roller and until the surface is true to grade and cross sections.

After the coarse stone for each layer has been spread, compacted, mechanically bonded, and presents a smooth, uniform surface, it shall be covered with a thin, uniform layer of choke stone and again rolled in the dry. In order to facilitate the filling of voids, fiber brooms shall be utilized. After all the voids have been filled, as far as possible, with

choke stone, by spreading, rolling and brooming the layer in the dry, water shall be sprinkled on the layer and the spreading of choke stone, brooming and rolling continued. The process of rolling, spreading of choke stone, brooming, and sprinkling shall continue until the material is compacted to 100 per cent of maximum density at optimum moisture as determined by laboratory methods, and until all voids are filled and a thoroughly compacted layer, free from waves and irregularities and true to line, grade and cross section is produced.

The finished surface shall not vary more than ½ inch from the approved cross section and grade when checked by a templet cut to the required cross section and with a 10-foot straightedge. The templet and straightedge shall be furnished by the contractor.

Should it develop that, during the construction, or after the completion of the first course, and during the construction of any of the succeeding courses, the subgrade material has been churned up or mixed with the crushed stone of the first layer, the contractor shall immediately, without compensation, entirely remove the defective portions of the construction and reconstruct the subgrade and each layer individually until the defective construction has been brought to the same standard of quality and the same status as adjacent construction.

All material necessary to be removed on account of defective construction shall be discarded and replaced with new material meeting the requirements of these specifications.

Just prior to subsequent construction on the base, the base shall be thoroughly cleaned with fiber brooms or other approved methods which will leave the surface smooth and free of cakes of dust or dirt or other objectionable materials and sufficiently rough to afford good mechanical bond with the next course but which will not distrub the base more than ⅛ inch below the surface of the completed base.

(b) All Other Aggregate Base Courses: When a course of base material has been spread, mixed and shaped as above specified, it shall be watered and given a preliminary rolling. Any waves or irregularities that may develop under rolling shall be corrected by scarifying and adding or removing base material until the surface presents a smooth appearance. Between rollings, the surface shall be machined.

Machining, watering and rolling shall continue until the material is compacted to 100 per cent of maximum density at optimum moisture as determined by laboratory methods before any subsequent course is begun. Rolling of all but the last course shall begin at one side and continue across the base course until the entire surface has been rolled. The rolling of the last course shall begin at one edge of the base course with the wheels overlapping the shoulders at least ½ the width of the roller and progress gradually to the center of the road overlapping each preceding track by ½ width. Rolling shall then begin at the opposite edge and proceed in like manner.

All rolling shall be accomplished by any method or combination of methods that will obtain the required compaction.

During the rolling and machining operations, the surface of the base course may be tested with a templet cut to the required cross section and with a 10-foot straightedge if directed by the engineer. All irregularities shall be corrected by scarifying to a depth of not less than 4 inches and removing or adding base material as may be required after which the entire area shall be watered, rolled and brought to a satisfactory state of compaction. The finished surface shall not vary more than ½ inch from the approved cross section and grade when checked by the templet and straightedge. The templet and straightedge shall be furnished by the contractor.

When the use of forms is required by the plans or special provisions, before rolling the top course of the base, the earth shoulders shall be constructed to full height and cross section as the form boards are removed.

2.17 Opening to Traffic:

(a) Crushed Stone Base Course: Traffic will be allowed over the completed base only when permitted by the engineer. In the event traffic is permitted to use the completed base, the contractor will be required to broom the completed surface as specified in Article 2.16 (a) prior to any subsequent construction.

(b) All Other Aggregate Base Course: The completed base shall be opened to traffic as provided in the specifications and special provisions covering maintenance of traffic. Weak spots which may develop shall be satisfactorily corrected and the base shall be kept free from holes, waves

and undulations and true to profile grade and cross section. The base shall not be allowed to become dusty with consequent loss of binder and loosening of the surface and shall be kept moist as directed by the engineer.

2.18 Shoulders, Ditches and Slopes:

The shoulders, ditches and slopes shall be constructed as set forth in Article 4.13, Part 1, Division II.

2.19 Field Laboratory:

The contractor shall provide a small laboratory building for the use of the engineer which shall be a minimum size of 8′ x 10′ and shall preferably be of the movable type so that it may be readily moved and placed near the area of construction. A work table 36″ in height and 30″ deep across the entire back of the building shall also be provided. The building shall have one outside door and not less than 2 windows. The roof, floor and walls shall be weathertight. The laboratory building shall be for the exclusive use of the engineer and shall become the property of the contractor and be disposed of by him upon completion of the project.

MEASUREMENT AND PAYMENT

2.20 Method of Measurement:

Measurement of all aggregate and special binder will be made by the cubic yard in vehicles at the point of delivery on the road as provided in Article 9.01, Division I.

If the base is composed of crushed stone, each of the component sizes of aggregate entering into the completed base will be measured separately.

If the base is composed of clam and reef shell, no differentiation will be made in the measurement of the different types of shell.

If the base is composed of sand clay gravel or iron ore and it consists of a natural mixture or an artificial mixture that has been mixed prior to being placed on the road, the base will be measured as provided above. However, if the several materials making up the base are placed on the job separately and mixed in place during construction, the several materials will be measured separately as provided above. The measured quantities of the several materials will then be added and the total thereof shall be reduced by the shrinkage factor as determined in the laboratory

in order to determine the pay quantity of the completed base course.

Roadside binder will be measured by the cubic yard as "excavation" as provided under Article 4.14, Part 1, Division II.

2.21 Basis of Payment:

The quantity of material placed and accepted, measured as provided above, shall be paid for at the contract price per cubic yard for each of the various materials incorporated in the base course, which price and payment shall constitute full compensation for the furnishing of all material except roadside binder; for all loading, hauling, unloading, spreading, mixing, shaping, rolling and watering; preparation of the subgrade, or clearing and reshaping the base course and shoulders; maintaining the finished surface until accepted and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

The quantity of roadside binder used in the base course will not be paid for as an item of base course construction, but will be paid for as provided under Article 4.15, Part 1, Division II.

Payment will be made under:

Item 2-2-1, Crushed Stone Base Course, Size 1, per cubic yard.
Item 2-2-2, Crushed Stone Base Course, Size 2, per cubic yard.
Item 2-2-3, Crushed Stone Base Course, Size 3, per cubic yard.
Item 2-2-4, Washed Gravel Base Course, per cubic yard.
Item 2-2-5, Washed Sand Gravel Base Course, per cubic yard.
Item 2-2-6, Sand Clay Gravel Base Course, per cubic yard.
Item 2-2-7, Iron Ore Base Course, per cubic yard.
Item 2-2-8, Clam Shell Base Course, per cubic yard.
Item 2-2-9, Reef Shell Base Course, per cubic yard.
Item 2-2-10, Clam and Reef Shell Base Course, per cubic yard.
Item 2-2-11, Special Binder, per cubic yard.

SECTION 3

SOIL CEMENT BASE COURSE

3.01 Description:

This item shall consist of a foundation course for the surface course. The base shall be composed of a combination of soil and Portland cement uniformly mixed, moistened and compacted in accordance with these specifications, and shaped to conform to the lines, grades, thickness and typical cross sections shown on the plans. Construction shall proceed as follows:

(a) The soil in the roadway shall be loosened and pulverized for the necessary depth and to the full width to be treated with cement.

(b) Portland cement shall be uniformly spread and mixed with the pulverized soil.

(c) Water shall be added as needed and shall be uniformly incorporated in the mixture in the amounts required to attain the optimum moisture content specified by the engineer for the soil cement mixture.

(d) The mixture shall be compacted uniformly with sheeps foot or pneumatic-tired rollers, as directed, in one continuous operation from the bottom of treatment to the surface. The mixture shall be compacted at the moisture content and to the density hereinafter specified.

(e) After compaction is completed with the sheeps foot or pneumatic-tired rollers, the surface shall be shaped, and then finished with a pneumatic-tired roller.

3.02 Equipment:

All equipment used shall be in suitable operating condition and approved by the engineer. Equipment not satisfactory to the engineer shall be removed and satisfactory equipment supplied.

Power distributors shall be equipped with pneumatic tires of such width and design so that the load produced on the road surface shall not exceed 650 pounds per inch width of tire. Distributors 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, including 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 bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the screens shall be cleaned frequently to prevent clogging of the nozzles. The distributor shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous 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 bituminous material at a rate of from 0.05 gallon to 2.0 gallons per square yard at a pressure of from 25 to 75 pounds and in variable widths up to the maximum required width.

The mixing machine shall be of a type that will satisfactorily mix the soil, cement and water, and shall be capable of producing a satisfactory product. The machine shall be equipped with approved watering devices so that water can be introduced in the exact proportion required to perform the moist mixing operation.

MATERIALS

3.03 Portland Cement:

Cement shall meet the requirements of Article 5.03, Part 4, Division II. The contractor, at his option, will be permitted to use bulk cement provided that the apparatus for handling, weighing and spreading the bulk cement is approved by the engineer in writing.

3.04 Water:

Water applied to the soil cement mixture shall meet the requirements of Article 5.05, Part 4, Division II.

3.05 Soil:

The soil for the base course shall consist of a natural material in the roadway or selected soil which shall be approved by the engineer. Selected materials placed as soil for the base course shall conform to the requirements for "suitable material" as contained in Article 4.10, Part 1, Division II, and shall, in addition, be soil that will stabilize with Portland cement.

3.06 Emulsified Asphalt:

Emulsified Asphalt shall be homogeneous and show no separation of asphalt, after thorough mixing, within 30 days after delivery, provided separation was not caused by freezing, and shall conform to the following requirements:

GRADE EA-4

	Minimum	Maximum
Viscosity, Saybolt Furol, @ 77° F, sec	40	400
Miscibility, 2 hrs	.....	Meet
Miscibility Modified	.....	4.5
Residue by Distillation, %	60	65
Settlement, 10 days, %	.....	3
Demulsibility, 50 ml. of 0.1 N, $CaCl_2$, %	.....	2
Sieve Test, %	.....	.05
Cement Mixing Test, %	.....	2
Stone Coating Test	.....	Meet
Dehydration, 100° F, 96 hrs	0.6	.....
Adhesion (Standard Rhyolite), %	75	.....
Tests on Residue from Distillation:		
Penetration @ 77° F, 100g, 5 sec	100	200
Soluble in CS_2	97	.....
Loss @ 325° F, 5 hrs., %	.....	1.0
Ductility @ 77° F, cm	60	.....
Ash	.....	2

Sampling: At least one sample of not less than one gallon shall be taken from each lot or shipment of the emulsified asphalt after arrival at its destination. The samples shall be stored in clean, airtight containers at a temperature not lower than 40°F until tested.

Method of Testing: The properties enumerated in these specifications shall be determined in accordance with the Methods of Testing Emulsified Asphalts, A.S.T.M. Designation: D 244, except as follows:

Dehydration Test: A 100 gram sample of the emulsion to be tested shall be placed in a tared, heat-resistant glass dish, 77 mm. inside diameter, 40 mm. in height, and having a flat bottom and straight sides. The dish and sample shall be placed in the center of a shallow pan about 5 inches inside diameter, and 50 grams of granular anhydrous $CaCl_2$ shall be spread in the pan so that it surrounds the dish containing the emulsion. The entire unit shall then be placed

in an oven at a constant temperature of 100°F. At the end of exactly 96 hours, during which time the sample shall not be disturbed by stirring or excessive movement, the loss in weight of the emulsion shall be determined. The dehydration loss shall be expressed as the ratio of loss in this test in 96 hours to loss in the test for residue at 325°F.

Adhesion Test: The adhesive qualities of the emulsified asphalt shall be tested by the following method:

Two hundred grams of dry Standard Massachusetts Rhyolite, graded to pass a No. 4 standard laboratory sieve and to be retained on a No. 10 standard laboratory sieve, shall be mixed with 16 grams of the emulsion to be tested until all particles of the aggregate are completely coated. Three 50-gram samples shall be selected from this mixture and spread on small metal discs. The prepared samples shall then be placed in an oven and dried for a period of 24 hours at a constant temperature of 200°F.

Each sample shall then be dropped into 400 cc. of boiling distilled water in a 600 cc. beaker and stirred for exactly 3 minutes at the rate of 60 times per minute, while boiling continues. The beaker shall then be removed from the fire, and after ebullition ceases, cold water shall be run into the beaker through a ¼ inch hose submerged about one inch below the surface. The addition of water shall be continued until the film of asphalt floating on the water in the beaker has flowed over the side. As soon as this is accomplished, each sample shall be removed and laid on absorbent paper for air-drying. In removing the samples from the beaker, care shall be taken to prevent the recoating of the samples with asphalt which has deposited on the beaker. When dry, the mixture shall be immediately examined. Areas showing any asphaltic film, either a heavy black or a very thin translucent asphaltic film, shall be considered coated and an estimate shall be made of the per cent coated.

CONSTRUCTION METHODS

3.07 Preparation of Existing Roadway:

Before undertaking other construction operations, the existing roadway shall be graded and shaped to conform with the grades, lines and cross section required for the completed roadway. Any additional soil needed shall be placed as the engineer may direct and any unsuitable ma-

terial shall be removed and replaced with materials acceptable to the engineer and meeting the requirements of Article 3.05.

3.08 Application of Cement, Pulverizing, Mixing and Application of Water:

Portland cement in the amount shown on the plans or specified in the proposal, shall be uniformly spread over the surface. No equipment, except that used in spreading, will be allowed to pass over the freshly spread cement until it is mixed with the soil. The soil shall be pulverized, and the Portland cement, soil and water shall be thoroughly mixed by the use of a mixing machine meeting the requirements specified herein. It shall be thoroughly mixed to the width and depth specified on the plans. When the width of the machine is insufficient to handle the full width of the base, it shall work forward in successive increments so that the base course may be compacted and finished for its full width in one operation. Precaution must be exercised to obtain the specified depth and straight longitudinal edges.

Seventy per cent of the pulverized soil, by dry weight, exclusive of gravel or stone, when tested by laboratory sieve, shall pass the No. 4 sieve.

Water shall be applied at a uniform rate and in such quantities as directed by the engineer and the soil shall be machined until the percentage of moisture in the soil does not exceed by more than 2 the percentage of moisture specified by the engineer for the soil cement mixture.

The optimum moisture and density requirements of the soil cement mix shall be predetermined by laboratory tests in accordance with the Method of Test for Moisture-Density Relations of Soil-Cement Mixtures, A.A.S.H.O. Designation: T 134, except compaction of the wet soil cement mix for each specimen shall be delayed for a period of time approximating that required for "moist mixing" during construction. When water spreading and mixing is completed, the percentage of moisture in the mixture, on the basis of oven dry weight, shall not vary from the specified optimum percentage of moisture for the mixture by more than 2 percentage points. The moisture in the soil cement mixture shall be that prevailing in the moist soil cement at the time of compaction and shall be determined in the field on rep-

resentative samples of the soil cement mixture obtained from the roadway toward the conclusion of moist mixing operations.

3.09 Compaction:

Upon completion of the moist mixing operation, the mixture shall be uniformly compacted with a sheeps foot roller or a pneumatic-tired roller as hereinafter provided. Compaction shall continue until the entire depth of soil cement mixture is uniformly compacted and a density of 95 per cent of maximum density at optimum moisture has been obtained. This specified density shall be that prevailing in the moist soil cement at the time of compaction and shall be determined in the field by the Methods of Test for Moisture-Density Relations of Soil-Cement Mixtures, A.A.S.H.O. Designation: T 134, on representative samples of soil cement mixture obtained from the roadway toward the conclusion of moist mixing operations. Such samples shall be within the moisture range specified in Article 3.08. The sheeps foot roller shall be of the size, shape and weight specified by the engineer as best suited to give the required densities in the soil cement mixture being compacted. In general, sandy soils will require unit pressures of 50 to 100 pounds per square inch with tamping feet of 10 to 12 square inch area; sandy loams and light clay loams will require unit pressures of 100 to 200 pounds per square inch with tamping feet of approximately 7 square inch area; and heavy clays and soils containing considerable aggregate will require unit pressures of 200 to 400 pounds per square inch with tamping feet of 5 to 6 square inch area. The sheeps foot roller shall be of the oscillating type.

If the material being compacted is a sand that will not compact with a sheeps foot roller, a pneumatic-tired roller of an approved type shall be used and such roller shall be designed with 2 axles and the wheels on the front and back axle shall be staggered and so spaced as to cover the entire width between the outside rear wheels with one passage of the roller. The roller shall be of the trailer type so designed and constructed as to provide for the addition of weights and shall be drawn by pneumatic-tired equipment having sufficient power for satisfactory operation. It shall weigh, under operating conditions, not less than 5 tons for a rolling width of 60 inches.

Compaction shall start immediately following completion of mixing operations and the rate of operation and number of rollers shall be sufficient to compact uniformly the section of base course being processed for the specified width and depth within 2 hours.

When the rollers are about ⅔ packed out, the motor grader shall start shaping to crown and grade while the rolling continues. During the preliminary shaping, additional water shall be added, if samples taken from the roadway indicate additional water is necessary to bring the soil cement back to within the specified moisture variation, and such additional moisture shall be mixed in with field cultivators and disc harrows properly adjusted so they do not loosen material already compacted. Upon completion of rolling, if the surface has dried out, a small increment of water shall be sprayed on the section before final blading operations begin.

After the mixture is compacted, the surface of the treated roadway shall be reshaped to the required lines, grades and cross sections and then shall be lightly scarified to loosen any imprints left by the compacting or shaping equipment, until a surface mulch of not more than one inch in thickness is obtained. The resulting surface shall then be thoroughly rolled with a pneumatic-tired roller. The rolling shall be done in such manner as to produce a smooth, closely-knit surface, free from cracks, ridges or loose material, conforming to the crown, grade and line shown on the plans.

3.10 Construction Joints:

At the end of each section processed, as soon as the smooth rolling has been completed, a trench 6 inches in depth or to the depth of the treatment and a foot or so wide shall be cut across the road at the end of the section where uniform cement and moisture content has been attained with proper density and where crown and grade have been established. This trench shall be at right angles to the center line and the side adjacent to the day's work shall be cut vertical and true to string line. Two 6-inch square timbers, each equal in length to ½ the width of the treatment, shall be laid against the vertical face to act as a header. Special manipulation will be required in mixing and placing soil cement mixture adjacent to the header on succeeding work.

3.11 Protection:

Immediately after smooth rolling is completed, the base shall be protected against rapid drying for a period of 7 days by applying emulsified asphalt at the rate of 0.20 to 0.25 gallon per square yard. The asphalt content of the emulsified asphalt shall be reduced by the addition of an equal amount of water before being applied. The resulting mixture of emulsified asphalt and water when tested shall show a residue by distillation of 30.0 to 32.5 per cent. The water and asphalt shall be thoroughly mixed by circulation in the distributor. The emulsion shall be applied uniformly to the base with a distributor as directed by the engineer and shall extend one foot on each side of the finished width of the base course to insure proper protection.

In the event the emulsion is washed off the base by rain or fails to remain on the base for any reason before the base is opened to traffic, the contractor shall replace same at his own expense.

At junctions and crossings where the contractor is required to maintain through highway traffic across the newly constructed soil cement base course, he shall protect the base course in accordance with the applicable requirements of Article 5.43, Part 3, Division II and the duration of such protection shall meet the requirements of this article.

Any finished portion of the base course adjacent to construction which is traveled by equipment used in constructing an adjoining section shall be continuously covered with at least 6 inches of earth to prevent equipment from marring the surface of the completed work.

The contractor will be permitted to drive pneumatic-tired equipment required for hauling cement and water and for shaping the section after the surface has hardened sufficiently to prevent the equipment marring the surface, provided protection as hereinbefore specified is not impaired.

3.12 Opening to Traffic:

Completed sections of the base shall be opened to traffic at the end of the 7-day protection period provided the surface has hardened sufficiently to prevent excessive marring.

3.13 Construction Limitations:

Cement shall be applied only to such an area that all the operations as hereinbefore specified under Articles 3.08 to 3.11, inclusive, can be continuous, and all but final surface finish completed within 6 hours after the beginning of water application to the thoroughly mixed soil cement. No cement shall be applied when the percentage of moisture in the soil in the subgrade immediately beneath the pulverized material exceeds the optimum moisture content specified by the engineer for that particular soil or when the percentage of moisture in the pulverized soil exceeds the optimum moisture of the soil cement mixture by more than two. When any of the operations after the application of cement are interrupted for more than 2 hours for any reason, or when the uncompacted soil cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given as hereinbefore specified under Article 3.08, the entire section shall be reconstructed in accordance with this specification. No measurement or payment will be allowed for such reconstruction.

3.14 Weather Limitations:

During seasons of probable freezing temperature, no cement shall be applied when a descending air temperature in the shade and away from artificial heat falls below 40°F nor resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

3.15 Surface Requirements:

For the purpose of testing the finished surface, a 10-foot straightedge shall be available on the work. Any variation in excess of ¼ inch when tested with the 10-foot straightedge shall be immediately corrected by loosening the surface of the irregular area and by removing excess material or adding material as the case may require, after which it shall be sprinkled and recompacted to true grade as required for new work.

3.16 Maintenance and Correction:

The contractor shall be required to maintain the completed roadway within the limits of his contract, in good condition satisfactory to the engineer from the time he first starts work until all work shall have been completed

and accepted. All irregularities or other defects that may occur shall be immediately repaired by the contractor at his own expense.

3.17 Field Laboratory:

The contractor shall provide a small laboratory building for the use of the engineer which shall be a minimum size of 8′ x 10′ and shall preferably be of the movable type so that it may be readily moved and placed near the area of construction. A work table 36″ in height and 30″ deep across the entire back of the building shall also be provided. The building shall have one outside door and not less than 2 windows. The roof, floor and walls shall be weather-tight. The laboratory building shall be for the exclusive use of the engineer and shall become the property of the contractor and be disposed of by him upon completion of the project.

MEASUREMENT AND PAYMENT

3.18 Method of Measurement:

Soil cement base course will be measured by the square yard. The width for measurement will be that shown on the plans. The length will be the actual center line length measured along the riding surface.

3.19 Basis of Payment:

The number of square yards of completed and accepted soil cement base course, measured as provided above shall be paid for at the contract unit price per square yard for "Soil Cement Base Course," complete in place, which price and payment shall constitute full compensation for furnishing all materials except suitable materials furnished under "excavation," for all equipment, tools and the performance of all work incidental to the satisfactory completion of the item.

Payment will be made under:

Item 2-3-1, Soil Cement Base Course, per square yard.

SECTION 4

FLEXIBLE BASE COURSE

4.01 Description:

This item shall consist of a foundation course for the surface course or pavement. The base shall be constructed on the prepared subgrade or reconstructed base course in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross sections shown on the plans. The base course shall be the type 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:

Crushed Stone Base Course
Gravel Base Course
Iron Ore Base Course
Shell Base Course
Shell and Sand Base Course

The type of base course material selected for use shall be used throughout the project.

4.02 Equipment:

All equipment for the proper construction of the base shall be on the project in first class working condition, and shall have been approved by the engineer before construction begins.

The equipment outfit furnished by the contractor shall conform to the applicable requirements of Article 2.02, Part 2, Division II.

MATERIALS

4.03 Crushed Stone:

Crushed Stone shall meet the requirements of Article 2.03, Part 2, Division II.

4.04 Gravel:

Gravel shall meet the requirements of sand clay gravel contained in Article 2.06, Part 2, Division II.

4.05 Iron Ore:

Iron Ore shall meet the requirements of Article 2.07, Part 2, Division II.

4.06 Shell:

Shell shall meet the requirements of Clam and Reef Shell contained in Article 2.10, Part 2, Division II.

4.07 Shell and Sand:

Shell and Sand shall meet the requirements of Article 6.03, Part 2, Division II.

CONSTRUCTION METHODS

4.08 General:

The various types of base herein, except shell and sand base, shall be constructed in accordance with the applicable requirements of "Construction Methods," Articles 2.12 to 2.19, inclusive, Part 2, Division II, except as hereinafter amended.

Sand and shell base shall be constructed in accordance with the requirements of "Construction Methods," Articles 6.04 to 6.08, inclusive, Part 2, Division II, except as hereinafter amended.

Article 2.14 or Article 6.05, as the case may be, "Transporting and Spreading Base Material," is amended to include and following:

The estimated volume of material to be placed on the road shall be determined by the compaction factor indicated on the plans and the shrinkage factor, when applicable, as determined in the laboratory, and the volume of material so placed shall be considered to equal the compacted thickness indicated on the plans.

MEASUREMENT AND PAYMENT

4.09 Method of Measurement:

Flexible base course will be measured by the square yard, complete in place. The width for measurement will be that shown on the plans or in the special provisions. The length will be the actual center line length measured along the finished base course.

Note: The estimated volume in cubic yards of base material required to construct the finished base to the required compacted thickness and cross section will be indicated on the plans or in the special provisions.

The Department, in order to determine that sufficient material is being delivered to obtain the required compacted

thickness and section, will measure the volume of loose material placed on the project. Such measurement will be made by the cubic yard in vehicles at the point of delivery on the road as provided in Article 9.01, Division I.

In the event the base is constructed of gravel or iron ore, and the several materials are placed on the job separately and mixed in place during construction, the several materials will be measured separately by the cubic yard in vehicles at the point of delivery on the road as provided in Article 9.01, Division I. The measured quantities of the several materials will be added and the total thereof shall be reduced by the shrinkage factor as determined in the laboratory in order to determine the volume of material placed.

In the event the base is constructed of shell, and the clam shell and reef shell are delivered separately, no differentiation will be made in clam and reef shell for the purpose of measurement.

In the event the base is constructed of shell and sand, and the component parts are delivered separately, no differentiation will be made in shell and sand for the purpose of measurement.

No additional compensation will be allowed the contractor should the estimated volume when placed on the road provide a compacted thickness in excess of that indicated on the plans, nor will any deduction be made should it provide a compacted thickness less than that indicated on the plans.

4.10 Basis of Payment:

The number of square yards of base course, complete in place and accepted, measured as provided above, shall be paid for at the contract price per square yard for "Flexible Base Course," which price and payment shall constitute full compensation for the furnishing of all material; for all loading, hauling, unloading, spreading, mixing, shaping, rolling, watering, preparation of the subgrade, or clearing and reshaping the base course and shoulders; and for furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Should the engineer order, in writing, an increase or decrease in compacted thickness of the base course, a pro-

portionate increase or decrease, as the case may be, will be made in the contract unit price per square yard.

Payment will be made under:

Item 2-4-1, Flexible Base Course, per square yard.

SECTION 5

PATCHING AND WIDENING EXISTING CONCRETE PAVEMENT

5.01 Description:

These items shall consist of patching and widening existing concrete pavement prior to placing binder course and/or wearing course of bituminous mixture for hot application, in accordance with these specifications and in conformity with the lines, grades and typical cross sections shown on the plans, or as directed by the engineer.

The contractor will be permitted to perform his patching and widening operations by either Method 1 or Method 2 or Method 3, as he elects, however the same method shall be employed throughout the project. The various methods are indicated on the plans and are further described as follows:

Method 1: Patching and widening with Portland cement concrete pavement.

Method 2: Patching with either Portland cement concrete pavement or bituminous mixture for hot application (binder course) and widening with bituminous mixture for hot application (binder course).

Method 3: Patching in the same manner as provided under Method 2 and widening with flexible base course and bituminous mixture for hot application (binder course).

5.02 Equipment:

Equipment furnished shall meet the requirements contained in the various specifications for the different types of material that may be employed.

In addition the contractor shall furnish trench rollers or other approved types of equipment satisfactory for compacting the subgrade.

MATERIALS

5.03 General:

Materials for use in the different methods of patching and base widening that may be employed shall comply with the requirements of the specifications and special provisions applying thereto.

CONSTRUCTION METHODS

5.04 Patching and Widening under Method 1:

In the event Method 1 is employed by the contractor, the work shall consist of constructing Portland cement concrete pavement for base widening and patching in accordance with the plans and shall conform to the applicable requirements of Section 5, Part 3, Division II and the requirements of those specifications.

The following requirements apply to both widening and patching the existing pavement:

In lieu of using regular Portland cement provided for by the specifications, the contractor will be permitted, if he so elects, to use high early strength Portland cement, or 10 per cent additional regular cement.

The contractor will be permitted to use wet batched concrete with either normal Portland cement with air-entraining admixtures or air-entraining cement as provided in Article 5.20, Part 4, Division II.

Concrete pavement for patching and base widening, constructed using high early strength Portland cement or 10 per cent additional regular cement shall be cured in accordance with the requirements of the subparagraph "Method of Curing Concrete Constructed with High Early Strength Portland Cement," contained in Article 5.42, Part 3, Division II.

Concrete pavement for patching and base widening constructed using regular standard Portland cement, or constructed using wet batched concrete shall be cured in accordance with the requirements of Article 5.42, Part 3, Division II.

Hand methods of consolidating and finishing will be permitted.

The contractor will be required to perform his operations during widening and patching the existing pavement in accordance with the requirements of the special provisions covering maintenance of traffic.

The following requirement applies to widening operations only:

The contractor will be permitted to perform his widening operations by mechanical methods. The machine used must be approved by the engineer and shall generally be of such design that the concrete is mechanically deposited on the prepared subgrade and it must be equipped with agitating strike-off attachment and leveling screed. The screed shall be so constructed that either end may be raised or lowered in order to get banking effect around curves. The machine must be of such design that the material flows evenly from hopper, to conveyor belt, to strike-off hopper, and to leveling screed. No forms will be required, but the machine must be equipped with a trailing shoe that immediately deposits sufficient earth against the edge of the freshly laid pavement to prevent sloughing off. In addition, where necessary immediate compaction by hand methods of this earth will be required. In the event such equipment is used, floating or other finishing will not be required, except where voids, uneven surfaces, or other irregularities appear. The slump of the concrete shall not be less than 1¼" nor more than 1¾".

The following requirements apply to patching operations only:

When new pavement abuts an existing dummy, construction or expansion joint, and dowels are found in place, such dowels shall be cut smooth at the edge of the pavement to remain in place. New dowel assembly at such locations will not be required.

The contractor shall furnish and install tie bar assembly, when indicated on the plans, conforming to the requirements for same contained in Section 5, Part 3, Division II.

Unless otherwise provided on the plans or in the special provisions, old pavement removed as required in connection with patching operations shall be disposed of beyond the limits of the project to the satisfaction of the engineer.

5.05 Patching and Widening under Method 2:

In the event Method 2 is employed by the contractor, the work shall consist of constructing bituminous mixture for hot application (binder course) for base widening and patching in accordance with the plans, all applicable require-

and uniformly mixed prior to placement in the base. Materials that are not properly mixed shall be removed and replaced with suitably mixed material. The engineer shall be the sole judge as to the uniformity of the mixture.

Bituminous materials placed for base widening under this method shall conform to all applicable requirements of the specifications for bituminous hot mixture contained in Section 3, Part 3, Division II.

5.07 Maintenance of Existing Shoulders:

Existing shoulders shall be maintained in such manner as to prevent as much water as possible from reaching the subgrade, all as directed by the engineer.

5.08 Excavation, Construction of Shoulders and Slopes:

Excavation for base widening and any required excavation for patching, and construction of shoulders and slopes, shall conform to the applicable requirements of Section 4, Part 1, Division II.

The quantity of excavation for base widening will vary dependent on the method employed by the contractor and the contractor is hereby advised that the estimated quantity of excavation shown on the plans may be increased or decreased.

In the event Method 3 is employed the contractor shall exercise care in placing embankment material over the aggregate subbase in order to avoid mixing such material with the subbase.

MEASUREMENT AND PAYMENT

5.09 Method of Measurement:

(a) Patching: Patching existing concrete 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 bituminous mixture for hot application, as the case may be.

Any required excavation in connection with patching operations will not be measured.

(b) Base Widening: Base widening will be measured by the station of 100 linear feet.

ments of the specifications for bituminous hot mixtures contained in Section 3, Part 3, Division II, and these specifications. Under this method, in lieu of patching with bituminous hot mix, the contractor will be permitted to perform patching operations using Portland cement concrete pavement in the same manner as provided for patching in Article 5.04.

Patching existing concrete pavement with bituminous hot mix shall be performed in the following manner:

The contractor shall perform such additional excavation necessary to place the bituminous mixture for patching to a depth of 12 inches. Materials so excavated shall be disposed of as directed. The bituminous hot mix placed for patching shall be consolidated and finished with mechanical tampers all as directed by the engineer.

Pavement removed as required by the plans in connection with patching operations, unless otherwise provided on the plans or in special provisions, shall be disposed of beyond the limits of the project to the satisfaction of the engineer.

5.06 Patching and Widening under Method 3:

In the event Method 3 is employed by the contractor the work shall consist of patching and base widening as hereinafter provided.

Patching existing concrete pavement shall be performed using either Portland cement concrete pavement or bituminous mixture for hot application, all as provided in Article 5.05.

Base widening shall consist of constructing flexible base course and placing bituminous mixture for hot application (binder course), all in accordance with the plans, all applicable requirements of the specifications for flexible base course, Section 4, Part 2, Division II, the specifications for bituminous hot mixtures contained in Section 3, Part 3, Division II, and these specifications.

Construction methods employed in placing the aggregate base course shall conform to the "Construction Methods" contained in Section 2, Part 2, Division II, with the following exception:

Article 2.15, Part 2, Division II is hereby amended to provide that mixing in place on the prepared subgrade will not be permitted. The several materials making up the particular type of base to be furnished shall be thoroughly

The length of measurement shall be computed in the following manner: When the total width for widening is to be constructed on one side only of the existing pavement, the length for measurement will be the length along the center line of the widened section. When the total width for widening is to be constructed ½ or more on one side and the remainder on the opposite side of the existing pavement, then both sides will be measured and the quantity to be paid for will be determined by dividing the summation of such lengths by two. Flares at intersections will be measured along a theoretical line ½ the distance from the outside of the widened section to the edge of the existing pavement. No differentiation will be made for any additional widening that may be ordered at curves.

Excavation required for base widening will be measured as provided under Article 4.14, Part 1, Division II.

Note: In order to be assured that sections shown on the plans are being obtained, the engineer may, in addition to making measurements as provided above, check the material on a yield or volumetric basis or by any other method in order to determine that sufficient materials are being placed. In the event it is determined by the engineer that insufficient materials are being placed, the engineer may order that additional materials be placed to obtain the required section.

5.10 Basis of Payment:

Patching and base widening in place and accepted, measured as provided above, will be paid for at the contract price per unit for "Patching" and "Base Widening," which prices and payments shall constitute full compensation for the removal and disposal of existing concrete pavement and any additional excavation that may be required in connection with patching operations; and for furnishing all materials, equipment, labor, tools and incidentals and the performance of all work necessary to complete the items.

Payment will be made under:

Item 2-5-1, Patching, per square yard.
Item 2-5-2, Base Widening (4 foot), per station.
Item 2-5-3, Base Widening (6 foot), per station.

Payment for excavation required in connection with base widening and shoulder and slope construction will be made in accordance with the applicable requirements of Article 4.15, Part 1, Division II.

SECTION 6

SHELL AND SAND BASE COURSE

6.01 Description:

This item shall consist of a foundation course for the surface course or pavement. The base shall be composed of shell and sand and shall be constructed on the prepared subgrade or reconstructed base course in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross sections shown on the plans.

6.02 Equipment:

All equipment for the proper construction of the base shall be on the project in first class working condition, and shall have been approved by the engineer before construction begins.

The equipment outfit furnished by the contractor shall conform to the applicable requirements of Article 2.02, Part 2, Division II.

MATERIALS

6.03 Shell and Sand:

The material shall consist of either a natural or artificial mixture of reef shell and sand combined in the approximate following proportions:

	Per Cent
Reef Shell	70
Sand	30

The reef shell may be either whole or crushed. The shell shall be washed or unwashed, and reasonably free from objectionable matter such as sticks, mud, clay and other deleterious substances.

Sand shall consist of fine sand or sandy loam and shall be practically free from roots, grass and other foreign materials.

Both the shell and sand shall be of such quality, that when properly proportioned and mixed, a satisfactory base

material will be produced. The mixture, when tested by means of laboratory sieves, shall meet the following requirements:

	Per Cent
Passing No. 40 Sieve	35 to 55

The fraction of the combined mixture passing the No. 40 sieve, when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87, shall meet the following physical characteristics:

Liquid Limit (Maximum)	25
Plastic Index (Maximum)	6

CONSTRUCTION METHODS

6.04 General:

"Subgrade," "Forms," "Shoulders, Ditches and Slopes," and "Field Laboratory," shall meet the respective requirements of Articles 2.12, 2.13, 2.18 and 2.19 of Part 2, Division II.

6.05 Transporting and Spreading Base Material:

The material shall be transported and spread in accordance with the requirements of Article 2.14 (b) and (c), Part 2, Division II.

6.06 Mixing:

In the event the several materials are placed separately upon the prepared subgrade, each type of material shall be spread uniformly over the full width of the base course. After all materials have been placed, the various types shall then be mixed to the full depth of the layer by approved machine methods. Traveling mixers and traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. However, the depth of combined materials placed in any one layer shall not exceed the requirements of Article 2.14 (b), Part 2, Division II. Mixing shall

continue until each type of material entering into the base course is uniformly distributed throughout the mass.

When the base course materials consist of a natural mixture or an artificial mixture that has been mixed prior to placing on the roadbed, the material shall be machine mixed in accordance with the preceding paragraph until there is a uniform distribution of the several materials throughout the mass.

In either event, the engineer shall be the sole judge as as to the uniformity of the mix.

Material shall be watered during mixing operations, when and if directed by the engineer. When uniform, the mixture shall again be spread smoothly to the typical cross section shown on the plans.

6.07 Compacting:

Shell and sand base course shall be compacted in accordance with the requirements of Article 2.16 (b), Part 2, Division II.

6.08 Opening to Traffic:

The completed base shall be opened to traffic as provided in Article 2.17 (b), Part 2, Division II.

MEASUREMENT AND PAYMENT

6.09 Method of Measurement:

Measurement of shell and sand will be made by the cubic yard in vehicles at the point of delivery on the road as provided in Article 9.01, Division I. If the component parts of the base are delivered separately, no differentiation will be made in the measurement of the different types of material.

6.10 Basis of Payment:

The quantity of material placed and accepted, measured as provided above, will be paid for at the contract price per cubic yard for "Shell and Sand Base Course," which price and payment shall constitute full compensation for the furnishing of all material; for all loading, hauling, unloading, spreading, mixing, shaping, rolling, watering, preparation of subgrade, or clearing and reshaping the base

course and shoulders; maintaining the finished surface until accepted and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 2-6-1, Shell and Sand Base Course, per cubic yard.

DIVISION II

Part 3—Surface Courses

INDEX

PART 3—DIVISION II

SECTION 1

AGGREGATE TYPE SURFACE COURSE

Crushed Stone Surface Course
Washed Gravel Surface Course
Washed Sand Gravel Surface Course
Sand Clay Gravel Surface Course
Iron Ore Surface Course
Clam Shell Surface Course
Reef Shell Surface Course
Clam and Reef Shell Surface Course

1.01 Description:

This item shall consist of a surface course of the type shown on the plans constructed on the prepared subgrade or reconstructed base course in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross sections shown on the plans.

1.02 Equipment:

All equipment for the proper construction of the surface course shall be on the project, in first class working condition, and shall have been approved by the engineer before construction begins.

1.03 Materials:

The materials used shall conform with the requirements of Articles 2.03 to 2.11, inclusive, Part 2, Division II, except as follows:

Crushed Stone: In lieu of the requirements contained in Article 2.03, Part 2, Division II, crushed stone shall conform to the following requirements:

Crushed stone shall consist of fragments of hard, durable particles of stone, excluding schist, shale or slate, uniformly graded in size, showing a per cent of wear of not more than 45 by the Los Angeles abrasion test and containing not more than 5 per cent of soft, friable material and not more than 5 per cent of flat or elongated pieces, and when tested by means of laboratory sieves shall meet the following requirements:

Sieve	Per Cent Passing
1½"	95 to 100
¾"	60 to 95
No. 4	0 to 15

Washed Gravel and Washed Sand Gravel: Washed gravel and washed sand gravel shall conform to the respective requirements of Articles 2.04 and 2.05, Part 2, Division II, and in addition, when tested by the Los Angeles abrasion test shall show a per cent of wear of not more than 45.

Sand Clay Gravel and Iron Ore: Sand clay gravel and iron ore shall conform to the respective requirements of Articles 2.06 and 2.07, Part 2, Division II, with the following exceptions:

The fraction of sand clay gravel (all grades) or iron ore (all grades) passing the No. 40 mesh sieve, when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87, shall meet the following physical characteristics:

Liquid Limit (Maximum)	35
Plastic Index	4 to 10

When tested by the Los Angeles abrasion test, sand clay gravel or iron ore shall show a per cent of wear of not more than 45.

Special Binder: Special binder shall meet the requirements of Article 2.11, Part 2, Division II, except as follows:

Liquid Limit (Maximum)	35
Plastic Index	4 to 10

CONSTRUCTION METHODS

1.04 Subgrade:

The subgrade shall be prepared accurately to line, grade and cross section as shown on the plans and directed by the engineer. The subgrade shall be approved before any surfacing material is placed.

1.05 Method:

The material shall be deposited in a windrow on the subgrade. The contractor shall be responsible for the uniform unloading and distribution of the required amount of material to obtain the section shown on the plans. The material shall be spread over the entire subgrade when and as so directed by the engineer and in accordance with the typical section on the approved plans.

1.06 Binder:

When shown on the plans, roadside binder or Special Binder shall be added to the surface course and thoroughly mixed as provided herein. When the use of roadside binder is indicated on the plans, suitable approved material will be obtained from the excavation and incorporated in the surface course as herein provided. When the use of Special Binder is indicated on the plans, materials meeting the specifications for Special Binder shall be furnished by the contractor and incorporated in the surface course as herein provided.

1.07 Mixing:

When surface course consists of a combination of different materials, the contractor will be required to mix the materials by plowing, harrowing, blading or other approved methods, all in accordance with the applicable requirements of Article 2.15, Part 2, Division II.

Material shall be watered during mixing operations, when and if directed by the engineer.

1.08 Shaping:

The roadway shall be opened to traffic when directed by the engineer and while being compacted under traffic, the material shall be shaped by the use of a blade grader or other suitable means. Ruts formed by traffic shall be filled by dragging the roadway at least once a day, and more frequently if necessary to prevent cutting through the surfacing material into the subgrade. Holes, waves, undulations and deficiencies in thickness which develop and which are not filled by blading shall be filled by adding more material. The material shall be shaped until it conforms to the cross section indicated on the plans and until it is free from ruts, waves and undulations. Shaping shall continue until the surface is satisfactory to the engineer.

MEASUREMENT AND PAYMENT

1.09 Method of Measurement:

Measurement of surface course material will be made by the cubic yard in vehicles at the point of delivery on the road as provided in Article 9.01, Division I.

When the surface course is composed of clam and reef shell, no differentiation will be made in the measurement of the different types of shell.

If the surface course is composed of sand clay gravel or iron ore and it consists of a natural mixture that has been mixed prior to being placed on the road, the surface course will be measured as provided above. However, if the several materials making up the surface course are placed on the job separately and mixed in place during construction, the several materials will be measured separately as provided above. The measured quantities of the several materials will then be added and the total thereof shall be reduced by the shrinkage factor as determined in the laboratory in order to determine the pay quantity of the completed surface course.

Roadside binder will be measured by the cubic yard as "excavation" as provided under Article 4.14, Part 1, Division II.

Special Binder will be measured by the cubic yard as provided under Article 2 .20, Part 2, Division II.

1.10 Basis of Payment:

The quantity of material placed and accepted, measured as provided above, shall be paid for at the contract price per cubic yard for each of the various materials incorporated in the surface course, which price and payment shall constitute full compensation for the furnishing of all material except roadside binder; for all loading, hauling, unloading, spreading, mixing, shaping, preparation of the subgrade or clearing and reshaping the surface course and shoulders; maintaining the finished surface until accepted and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

The quantity of roadside binder used in the surface course will not be paid for as an item of surface course construction, but will be paid for as provided under Article 4.15, Part 1, Division II.

Special Binder will be paid for under Item 2-2-11, per cubic yard, as provided under Article 2.21, Part 2, Division II.

Payment will be made under:

Item 3-1-1, Crushed Stone Surface Course, per cubic yard.

Item 3-1-2, Washed Gravel Surface Course, per cubic yard.

Item 3-1-3, Washed Sand Gravel Surface Course, per cubic yard.

Item 3-1-4, Sand Clay Gravel Surface Course, per cubic yard.

Item 3-1-5, Iron Ore Surface Course, per cubic yard.

Item 3-1-6, Clam Shell Surface Course, per cubic yard.

Item 3-1-7, Reef Shell Surface Course, per cubic yard.

Item 3-1-8, Clam and Reef Shell Surface Course, per cubic yard.

SECTION 2

BITUMINOUS SURFACE TREATMENT

2.01 Description:

This item shall consist of a wearing surface of mineral aggregate and bituminous materials constructed on a prepared base or on an existing pavement, as the case may be, in accordance with these specifications and in conformity with the lines, grades and typical cross sections shown on the plans, or as directed by the engineer.

2.02 Composition and Proportioning:

Bituminous surface treatment shall consist of the number of applications each of the specified sizes of mineral aggregate and the specified bituminous material, all as indicated on the plans or in the special provisions.

Aggregates shall be uncrushed gravel; crushed aggregate composed of crushed slag, crushed stone or crushed gravel; or clam shell aggregate, whole and crushed.

The particular type of bituminous surfacing shall be as indicated on the plans or in the special provisions and shall be one of the following types:

Type	Composition
1	Asphalt Cement, uncrushed gravel or crushed aggregate.
2	Cutback Asphalt, uncrushed gravel or crushed aggregate.
3	Emulsified Asphalt, uncrushed gravel or crushed aggregate.
4	Cutback Asphalt, clam shell aggregate.

Before constructing the wearing course, Grade MC-1 primer or Grade MC-2 primer, as directed by the engineer, shall be applied to the prepared base if Asphalt Cement or Cutback Asphalt is to be used in the construction of the wearing course. Emulsified Asphalt, Grade EA-5, shall be applied as primer if Emulsified Asphalt is to be used in the construction of the wearing course. Primers shall be applied to existing pavements when directed by the engineer. If the prepared base consists of soil cement, the primer may be reduced or deleted as directed by the engineer. Primers shall be applied at the rates and temperatures shown in Table I.

TABLE I

BITUMINOUS PRIMERS

	Primer (Gal. per Sq. Yd.)		Temperature of Application	
	Minimum	Maximum	Minimum	Maximum
Prime Application MC-1	0.25	0.3	80°F	150°F
Prime Application MC-2	0.25	0.3	100°F	200°F
Prime Application EA-5	0.25	0.3	60°F	120°F

The quantity of materials per square yard and the sequence of application and spreading for Type 1, Type 2 or Type 3 bituminous surfacing, as specified, shall be as shown in Table II.

TABLE II

QUANTITIES OF MATERIALS PER SQUARE YARD

	Gal. of Asphalt at 60°F			Cubic Yards of Aggregate		
	Asphalt Cement	Cutback Asphalt	Emulsified Asphalt	Size 1 Coarse	Size 2 Fine	Size 3 Seal
First Application	0.4	0.2	0.2			
Spreading				.0200		
Second Application	0.3	0.3	0.3			
Spreading					.0111	
Third Application	0.2	0.6	0.6			
Spreading						.0075
Totals	0.9	1.1	1.1	.0200	.0111	.0075

Temperature of Application	Minimum	Maximum
AC-8	275°F	350°F
RC-1	105°F	135°F
RC-2	125°F	155°F
RC-3	125°F	155°F
EA-2	100°F	150°F

The quantity of materials per square yard and the sequence of application and spreading for Type 4 bituminous surfacing shall be as shown in Table III.

TABLE III

QUANTITIES OF MATERIALS PER SQUARE YARD

	Gal. of Cutback Asphalt at 60°F	Cubic Yards of Clam Shell		
	Grade RC-2	Coarse	Fine	Seal
First Application	0.3			
Spreading		.0208		
Second Application	0.4			
Spreading			.0141	
Third Application	0.3			
Spreading				.0083
Totals	1.0	.0208	.0141	.0083

Temperature of Application	Minimum	Maximum
RC-2	125°F	155°F

The quantities shown in Tables I, II and III are approximate only. The actual quantities used shall be as directed by the engineer, however, in no case shall the actual quantities used vary from the rates shown by more than the following percentages:

The quantities of primer actually used shall not vary from the quantities shown in Table I by more than plus or minus 5 per cent, except primers to be applied to existing pavements and to base constructed of soil cement, in which cases the quantity of primer to be used shall be decreased or deleted as directed by the engineer.

The total quantities of asphalt and aggregates actually used for Type 1, Type 2 or Type 3 bituminous surfacing shall not vary from the quantities shown in Table II by more than plus or minus 10 per cent.

For Type 4 bituminous surfacing, the total quantity of asphalt used shall not vary from the quantity shown in Table III by more than plus or minus 10 per cent, and the

actual quantity of clam shell aggregate used shall not vary from the rate shown by more than plus or minus 20 per cent.

The quantities of bituminous material per square yard of treated surface as shown in Tables I, II and III are based on a temperature of 60°F. All volumetric measurements shall be converted to this temperature in accordance with the Temperature-Volume Correction Tables for Asphaltic Materials as set out in Article 2.09.

2.03 Equipment:

All equipment for the proper construction of this work shall be in first class working condition and shall have been approved by the engineer before construction begins and shall be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of the following units:

1. Broom dragging equipment, capable of covering ⅓ to ½ the width of the treatment.
2. Power distributor equipment, as hereinafter specified.
3. Power rollers, weighing not less than 5, nor more than 10 tons.
4. Power revolving broom, or a power blower.
5. Accurately controlled aggregate spreading equipment.

The power distributor shall be equipped with pneumatic tires of such width and design so that the load produced on the road surface shall not exceed 650 pounds per inch width of tire. 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, including 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 bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the screens shall be cleaned frequently to prevent clogging of the nozzles. The distributor shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous 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 bituminous material at a rate of from 0.05 gallon to 2.0 gallons per square yard at a pressure of from 25 to 75 pounds and in variable widths up to the width of the required prime coat.

MATERIALS

2.04 Aggregates:

(a) Type 1, Type 2 or Type 3 Bituminous Surfacing: Aggreate used in the construction of the wearing course under either Type 1 or Type 2 or Type 3 bituminous surfacing shall be either gravel or crushed aggregate and may be any one of the following types for each application, except that crushed stone may not be used in the third or seal coat application.

1. Gravel
2. Crushed Gravel
3. Crushed Stone
4. Crushed Slag

All of the above types, when tested with square opening laboratory sieves shall conform to the gradation requirements specified below for the various sizes:

Sieve	Per Cent by Weight Passing Square Openings		
	Coarse Aggregate Size 1	Fine Aggregate Size 2	Seal Coat Aggregate Size 3
1½"	100	.....	.....
1"	85 to 100	.....	.....
¾"	40 to 80	100	.....
⅝"	.....	95 to 100	.....
½"	0 to 15	.....	100
⅜"	.....	.....	95 to 100
No. 4	.....	0 to 7	30 to 60
No. 10	.....	.....	0 to 15
No. 16	.....	.....	0 to 5

Crushed Gravel: Crushed gravel shall consist of clean, tough, durable stone and shall be crushed and screened to conform to the gradation specified. A minimum of 80 per cent of the crushed gravel retained on the No. 10 sieve shall have one or more fractured faces. Crushed gravel shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed Stone: Crushed stone shall consist of clean, tough, sound, durable particles of stone. The particles of stone shall be free from dust, vegetable or other deleterious matter and shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. The stone shall not contain more than 15 per cent of thin, elongated particles (particles whose greatest dimension is more than 4 times its least dimension).

Crushed Slag: Crushed slag shall be air-cooled, blast furnace slag, and shall consist of angular fragments reasonably uniform in density and quality and reasonably free from flat or elongated particles, dirt or other deleterious substances. The slag shall not contain more than 10 per cent by weight of glassy particles. The crushed slag shall have a weight per cubic foot of not less than 70 pounds, using Method of Test for Unit Weight of Aggregate, A.A.S.H.O. Designation: T 19. Slag shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Uncrushed Gravel: This aggregate shall consist of uncrushed gravel. The gravel shall be clean, tough, durable stone free from sticks and clay coating. Gravel shall not contain more than 15 per cent of thin or elongated particles of stone and shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

(b) Type 4 Bituminous Surfacing: Aggregate used in the construction of the wearing course under Type 4 bituminous surfacing shall consist of clam shell. Clam shell furnished for coarse aggregate and for fine aggregate shall consist of whole dead clam shell, having a maximum size not exceeding 1½ inches. The shell shall be thoroughly washed and, after washing, shall contain not more than 2 per cent foreign matter.

Clam shell furnished for seal coat aggregate shall consist of either crushed dead clam shell or whole dead clam shell having a maximum size not exceeding 1½ inches, as

the contractor elects. In either case the shell shall be thoroughly washed and, after washing, shall contain not more than 2 per cent foreign matter. Crushed clam shell shall meet the following gradation requirements:

Sieve	Per Cent Passing
¾"	100
No. 4	0 to 10

The crushed clam shell shall be uniformly graded between the above requirements.

2.05 Bituminous Primers:

If emulsified asphalt is to be used in the construction of the wearing course, Grade EA-5 emulsified asphalt shall be used as primer. The emulsified asphalt shall be homogeneous and show no separation of asphalt after thorough mixing, within 30 days after delivery, provided separation was not caused by freezing. The emulsified asphalt primer shall comply with the requirements of Grade EA-5 as set forth under the specification for "Emulsified Asphalt" hereinafter contained in Article 2.08 and sampling and testing shall be in accordance therewith.

If asphalt cement or cutback asphalt is to be used in the construction of the wearing course, Grade MC-1 or Grade MC-2 cutback asphalt, as ordered by the engineer, shall be used as primer. Cutback asphalt primer (Grade MC-1 or Grade MC-2) shall be free from water, shall show no separation or curdling prior to use, and shall conform to the following requirements:

GRADES	MC-1		MC-2	
	Min.	Max.	Min.	Max.
Flash Point (Open Tag), °F	100	.....	150	.....
Viscosity, Saybolt Furol;				
@ 77°F, sec	75	150	.....	.....
@ 122°F, sec	.....	.....	100	200
Distillation Test:				
Distillate, Percentage by Volume of Total Distillate to 680°F;				
to 437°F	.....	20	.....	10
to 500°F	25	65	15	55
to 600°F	70	90	60	87
Residue from Distillation to 680°F, Percentage Volume by Difference	60	.....	67	.....
Tests on Residue from Distillation:				
Penetration	120	300	120	300
Ductility @ 77°F for Residues of less than 200 pen. @ 77°F, cm	100	.....	100	.....
Ductility @ 60°F for Residues of 200-300 pen. @ 77°F, cm	100	.....	100	.....
Solubility in Carbon Tetrachloride, %	99.5	.....	99.5	.....
Homogeneity Test	Negative for both grades			

Testing: Testing of medium curing cutback asphalts shall be in accordance with the latest revisions of the A.S.T.M. except for Flash Point (Open Tag) and Homogeneity. The test for Flash Point (Open Tag) shall be in accordance with the method approved by the Bureau of Explosives. The test for Homogeneity shall be in accordance with the Method of Spot Test of Asphaltic Materials, A.A.S.H.O. Designation: T 102.

2.06 Asphalt Cement:

Asphalt cement shall be homogeneous, free from water, shall not foam when heated to 347°F and shall conform to the following requirements:

GRADE AC-8

	Minimum	Maximum
Penetration @ 77°F, 100g, 5 sec	150	200
Flash Point, C.O.C., °F	347	.....
Loss @ 325°F, 50g, 5 hrs., %	.....	1
Penetration of Residue @ 77°F, 100g, 5 sec., Percentage of Original Penetration	65	.....
Bitumen Soluble in CS_2, %	99.5	.....
Ductility @ 77°F, cm	60	.....
Homogeneity Test	Negative	

Testing: Testing of asphalt cement shall be in accordance with the latest revisions of the A.S.T.M., except for Homogeneity. The test for Homogeneity shall be in accordance with Method of Spot Test of Asphaltic Materials, A.A.S.H.O. Designation: T 102.

2.07 Cutback Asphalt:

The cutback asphalt shall be free from water and shall show no separation or curdling prior to use.

Cutback asphalt of the grade specified shall conform to the following requirements:

GRADES	RC-1		RC-2		RC-3	
	Min.	Max.	Min.	Max.	Min.	Max.
Flash Point (Open Tag), °F	.....	.....	80	.....	80	.....
Viscosity, Saybolt Furol;						
@ 122°F, sec	75	150	.....	.....	.....	.....
@ 140°F, sec	.....	.....	100	200	250	500
Distillation Test:						
Distillate, Percentage by Volume of Total Distillate to 680°F;						
to 374°F	10	.....	.....	.....	.....	.....
to 437°F	50	.....	40	.....	25	.....
to 500°F	70	.....	65	.....	55	.....
to 600°F	88	.....	87	.....	83	.....
Residue from Distillation to 680°F, Percentage Volume by Difference	60	.....	67	.....	73	.....
Tests on Residue from Distillation:						
Penetration	80	120	80	120	80	120
Ductility @ 77°F, cm	100	.....	100	.....	100	.....
Solubility in Carbon Tetrachloride, %	99.5	.....	99.5	.....	99.5	.....
Homogeneity Test	Negative for all grades					

Testing: Testing of all cutback asphalts shall be in accordance with the latest revisions of the A.S.T.M. except for Flash Point (Open Tag) and Homogeneity. The test for Flash Point (Open Tag) shall be in accordance with the method approved by the Bureau of Explosives. The test for Homogeneity shall be in accordance with the Method of Spot Test of Asphaltic Materials, A.A.S.H.O. Designation: T 102.

2.08 Emulsified Asphalt:

Emulsified asphalt used in the wearing course shall be Grade EA-2. Emulsified asphalt used as primer shall be Grade EA-5.

Emulsified asphalt shall be homogeneous and show no separation of asphalt after thorough mixing, within 30 days after delivery, provided separation was not caused by freezing and shall conform to the following requirements:

GRADES	EA-2		EA-5	
	Min.	Max.	Min.	Max.
Viscosity, Saybolt Furol, @ 122°F, sec.	100	500	40	400
Residue by Distillation, %	62	67	60	.....
Settlement, 10 days, %	.....	3	.....	.....
Demulsibility, 50ml. of 0.1 N, $CaCl_2$, %	65	.....	.....	.....
Sieve Test, %	.....	.05	.....	.....
Stone Coating Test	.....	.....	.....	Meet
Water Content, %	.....	.....	3	8
Tests on Residue from Distillation:				
Penetration @ 77°F, 100g, 5 sec.	100	200	.....	.....
Soluble in CS_2	97	.....	97.5	.....
Loss @ 325°F, 5 hrs., %	.....	1.0	.....	.....
Ductility @ 77°F, cm.	60	.....	.....	.....
Float Test @ 122°F	.....	.....	80	.....
Ash	.....	2	.....	3

Sampling: At least one sample of not less than one gallon shall be taken from each lot or shipment of the emulsified asphalt after arrival at its destination. The samples shall be stored in clean air-tight containers at a temperature not lower than 40°F until tested.

Method of Testing: The properties enumerated in these specifications shall be determined in accordance with the Methods of Testing Emulsified Asphalts, A.S.T.M. Designation: D 244.

2.09 Temperature-Volume Corrections for Asphaltic Materials:

The following tables have been extracted from Standard ASTM-IP Petroleum Measurement Tables, A.S.T.M. Designation: D 1250.

Table 1 provides Temperature-Volume correction data for asphaltic materials having a specific gravity, at 60°F, above 0.966—designated by the A.S.T.M. as group 0 ma-

terials. Table 2 provides these data for asphaltic materials having a specific gravity, at 60°F, of 0.850 to 0.966 inclusive—designated by the A.S.T.M. as Group 1 materials.

TABLE 1

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 0—SPECIFIC GRAVITY AT 60°F. ABOVE 0.966

LEGEND:
t = observed temperature in degrees Fahrenheit;
M = multiplier for reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
0	1.0211	30	1.0105	60	1.0000	90	0.9896	120	0.9792
1	1.0208	31	1.0102	61	0.9997	91	0.9892	121	0.9788
2	1.0204	32	1.0098	62	0.9993	92	0.9889	122	0.9785
3	1.0201	33	1.0095	63	0.9990	93	0.9885	123	0.9782
4	1.0197	34	1.0091	64	0.9986	94	0.9882	124	0.9778
5	1.0194	35	1.0088	65	0.9983	95	0.9878	125	0.9775
6	1.0190	36	1.0084	66	0.9979	96	0.9875	126	0.9771
7	1.0186	37	1.0081	67	0.9976	97	0.9871	127	0.9768
8	1.0183	38	1.0077	68	0.9972	98	0.9868	128	0.9764
9	1.0179	39	1.0074	69	0.9969	99	0.9864	129	0.9761
10	1.0176	40	1.0070	70	0.9965	100	0.9861	130	0.9758
11	1.0172	41	1.0067	71	0.9962	101	0.9857	131	0.9754
12	1.0169	42	1.0063	72	0.9958	102	0.9854	132	0.9751
13	1.0165	43	1.0060	73	0.9955	103	0.9851	133	0.9747
14	1.0162	44	1.0056	74	0.9951	104	0.9847	134	0.9744
15	1.0158	45	1.0053	75	0.9948	105	0.9844	135	0.9740
16	1.0155	46	1.0049	76	0.9944	106	0.9840	136	0.9737
17	1.0151	47	1.0046	77	0.9941	107	0.9837	137	0.9734
18	1.0148	48	1.0042	78	0.9937	108	0.9833	138	0.9730
19	1.0144	49	1.0038	79	0.9934	109	0.9830	139	0.9727
20	1.0141	50	1.0035	80	0.9930	110	0.9826	140	0.9723
21	1.0137	51	1.0031	81	0.9927	111	0.9823	141	0.9720
22	1.0133	52	1.0028	82	0.9923	112	0.9819	142	0.9716
23	1.0130	53	1.0024	83	0.9920	113	0.9816	143	0.9713
24	1.0126	54	1.0021	84	0.9916	114	0.9813	144	0.9710
25	1.0123	55	1.0017	85	0.9913	115	0.9809	145	0.9706
26	1.0119	56	1.0014	86	0.9909	116	0.9806	146	0.9703
27	1.0116	57	1.0010	87	0.9906	117	0.9802	147	0.9699
28	1.0112	58	1.0007	88	0.9902	118	0.9799	148	0.9696
29	1.0109	59	1.0003	89	0.9899	119	0.9795	149	0.9693

TABLE 1—Continued

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 0—SPECIFIC GRAVITY AT 60°F. ABOVE 0.966

LEGEND:

t = observed temperature in degrees Fahrenheit;
M = multiplier for reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
150	0.9689	180	0.9587	210	0.9486	240	0.9385	270	0.9286
151	0.9686	181	0.9584	211	0.9483	241	0.9382	271	0.9283
152	0.9682	182	0.9580	212	0.9479	242	0.9379	272	0.9279
153	0.9679	183	0.9577	213	0.9476	243	0.9375	273	0.9276
154	0.9675	184	0.9574	214	0.9472	244	0.9372	274	0.9273
155	0.9672	185	0.9570	215	0.9469	245	0.9369	275	0.9269
156	0.9669	186	0.9567	216	0.9466	246	0.9365	276	0.9266
157	0.9665	187	0.9563	217	0.9462	247	0.9362	277	0.9263
158	0.9662	188	0.9560	218	0.9459	248	0.9359	278	0.9259
159	0.9658	189	0.9557	219	0.9456	249	0.9356	279	0.9256
160	0.9655	190	0.9553	220	0.9452	250	0.9352	280	0.9253
161	0.9652	191	0.9550	221	0.9449	251	0.9349	281	0.9250
162	0.9648	192	0.9547	222	0.9446	252	0.9346	282	0.9246
163	0.9645	193	0.9543	223	0.9442	253	0.9342	283	0.9243
164	0.9641	194	0.9540	224	0.9439	254	0.9339	284	0.9240
165	0.9638	195	0.9536	225	0.9436	255	0.9336	285	0.9236
166	0.9635	196	0.9533	226	0.9432	256	0.9332	286	0.9233
167	0.9631	197	0.9530	227	0.9429	257	0.9329	287	0.9230
168	0.9628	198	0.9526	228	0.9426	258	0.9326	288	0.9227
169	0.9624	199	0.9523	229	0.9422	259	0.9322	289	0.9223
170	0.9621	200	0.9520	230	0.9419	260	0.9319	290	0.9220
171	0.9618	201	0.9516	231	0.9416	261	0.9316	291	0.9217
172	0.9614	202	0.9513	232	0.9412	262	0.9312	292	0.9213
173	0.9611	203	0.9509	233	0.9409	263	0.9309	293	0.9210
174	0.9607	204	0.9506	234	0.9405	264	0.9306	294	0.9207
175	0.9604	205	0.9503	235	0.9402	265	0.9302	295	0.9204
176	0.9601	206	0.9499	236	0.9399	266	0.9299	296	0.9200
177	0.9597	207	0.9496	237	0.9395	267	0.9296	297	0.9197
178	0.9594	208	0.9493	238	0.9392	268	0.9293	298	0.9194
179	0.9590	209	0.9489	239	0.9389	269	0.9289	299	0.9190

TABLE 1—Continued

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 0—SPECIFIC GRAVITY AT 60°F. ABOVE 0.966

LEGEND:

t = observed temperature in degrees Fahrenheit;
M = multiplier for reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
300	0.9187	330	0.9089	360	0.8992	390	0.8896	420	0.8800
301	0.9184	331	0.9086	361	0.8989	391	0.8892	421	0.8797
302	0.9181	332	0.9083	362	0.8986	392	0.8889	422	0.8794
303	0.9177	333	0.9079	363	0.8982	393	0.8886	423	0.8791
304	0.9174	334	0.9076	364	0.8979	394	0.8883	424	0.8787
395	0.9171	335	0.9073	365	0.8976	395	0.8880	425	0.8784
306	0.9167	336	0.9070	366	0.8973	396	0.8876	426	0.8781
307	0.9164	337	0.9066	367	0.8969	397	0.8873	427	0.8778
308	0.9161	338	0.9063	368	0.8966	398	0.8870	428	0.8775
309	0.9158	339	0.9060	369	0.8963	399	0.8867	429	0.8772
310	0.9154	340	0.9057	370	0.8960	400	0.8864	430	0.8768
311	0.9151	341	0.9053	371	0.8957	401	0.8861	431	0.8765
312	0.9148	342	0.9050	372	0.8953	402	0.8857	432	0.8762
313	0.9145	343	0.9047	373	0.8950	403	0.8854	433	0.8759
314	0.9141	344	0.9044	374	0.8947	404	0.8851	434	0.8756
315	0.9138	345	0.9040	375	0.8944	405	0.8848	435	0.8753
316	0.9135	346	0.9037	376	0.8941	406	0.8845	436	0.8749
317	0.9132	347	0.9034	377	0.8937	407	0.8841	437	0.8746
318	0.9128	348	0.9031	378	0.8934	408	0.8838	438	0.8743
319	0.9125	349	0.9028	379	0.8931	409	0.8835	439	0.8740
320	0.9122	350	0.9024	380	0.8928	410	0.8832	440	0.8737
321	0.9118	351	0.9021	381	0.8924	411	0.8829	441	0.8734
322	0.9115	352	0.9018	382	0.8921	412	0.8826	442	0.8731
323	0.9112	353	0.9015	383	0.8918	413	0.8822	443	0.8727
324	0.9109	354	0.9011	384	0.8915	414	0.8819	444	0.8724
325	0.9105	355	0.9008	385	0.8912	415	0.8816	445	0.8721
326	0.9102	356	0.9005	386	0.8908	416	0.8813	446	0.8718
327	0.9099	357	0.9002	387	0.8905	417	0.8810	447	0.8715
328	0.9096	358	0.8998	388	0.8902	418	0.8806	448	0.8712
329	0.9092	359	0.8995	389	0.8899	419	0.8803	449	0.8709

TABLE 1—Continued

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 0—SPECIFIC GRAVITY AT 60°F. ABOVE 0.966

LEGEND:

t = observed temperature in degrees Fahrenheit;
M = multiplier for reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
450	0.8705	**460**	0.8674	**470**	0.8643	**480**	0.8611	**490**	0.8580
451	0.8702	**461**	0.8671	**471**	0.8640	**481**	0.8608	**491**	0.8577
452	0.8699	**462**	0.8668	**472**	0.8636	**482**	0.8605	**492**	0.8574
453	0.8696	**463**	0.8665	**473**	0.8633	**483**	0.8602	**493**	0.8571
454	0.8693	**464**	0.8661	**474**	0.8630	**484**	0.8599	**494**	0.8568
455	0.8690	**465**	0.8658	**475**	0.8627	**485**	0.8596	**495**	0.8565
456	0.8687	**466**	0.8655	**476**	0.8624	**486**	0.8593	**496**	0.8562
457	0.8683	**467**	0.8652	**477**	0.8621	**487**	0.8590	**497**	0.8559
458	0.8680	**468**	0.8649	**478**	0.8618	**488**	0.8587	**498**	0.8556
459	0.8677	**469**	0.8646	**479**	0.8615	**489**	0.8583	**499**	0.8552

TABLE 2

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 reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
0	1.0241	30	1.0120	60	1.0000	90	0.9881	120	0.9763
1	1.0237	31	1.0116	61	0.9996	91	0.9877	121	0.9760
2	1.0233	32	1.0112	62	0.9992	92	0.9873	122	0.9756
3	1.0229	33	1.0108	63	0.9988	93	0.9869	123	0.9752
4	1.0225	34	1.0104	64	0.9984	94	0.9865	124	0.9748
5	1.0221	35	1.0100	65	0.9980	95	0.9861	125	0.9744
6	1.0217	36	1.0096	66	0.9976	96	0.9857	126	0.9740
7	1.0213	37	1.0092	67	0.9972	97	0.9854	127	0.9736
8	1.0209	38	1.0088	68	0.9968	98	0.9850	128	0.9732
9	1.0205	39	1.0084	69	0.9964	99	0.9846	129	0.9728
10	1.0201	40	1.0080	70	0.9960	100	0.9842	130	0.9725
11	1.0197	41	1.0076	71	0.9956	101	0.9838	131	0.9721
12	1.0193	42	1.0072	72	0.9952	102	0.9834	132	0.9717
13	1.0189	43	1.0068	73	0.9948	103	0.9830	133	0.9713
14	1.0185	44	1.0064	74	0.9944	104	0.9826	134	0.9709
15	1.0181	45	1.0060	75	0.9940	105	0.9822	135	0.9705
16	1.0177	46	1.0056	76	0.9936	106	0.9818	136	0.9701
17	1.0173	47	1.0052	77	0.9932	107	0.9814	137	0.9697
18	1.0168	48	1.0048	78	0.9929	108	0.9810	138	0.9693
19	1.0164	49	1.0044	79	0.9925	109	0.9806	139	0.9690
20	1.0160	50	1.0040	80	0.9921	110	0.9803	140	0.9686
21	1.0156	51	1.0036	81	0.9917	111	0.9799	141	0.9682
22	1.0152	52	1.0032	82	0.9913	112	0.9795	142	0.9678
23	1.0148	53	1.0028	83	0.9909	113	0.9791	143	0.9674
24	1.0144	54	1.0024	84	0.9905	114	0.9787	144	0.9670
25	1.0140	55	1.0020	85	0.9901	115	0.9783	145	0.9666
26	1.0136	56	1.0016	86	0.9897	116	0.9779	146	0.9662
27	1.0132	57	1.0012	87	0.9893	117	0.9775	147	0.9659
28	1.0128	58	1.0008	88	0.9889	118	0.9771	148	0.9655
29	1.0124	59	1.0004	89	0.9885	119	0.9767	149	0.9651

TABLE 2—Continued

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 reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
150	0.9647	180	0.9532	210	0.9418	240	0.9305	270	0.9194
151	0.9643	181	0.9528	211	0.9414	241	0.9301	271	0.9190
152	0.9639	182	0.9524	212	0.9410	242	0.9298	272	0.9186
153	0.9635	183	0.9520	213	0.9407	243	0.9294	273	0.9182
154	0.9632	184	0.9517	214	0.9403	244	0.9290	274	0.9179
155	0.9628	185	0.9513	215	0.9399	245	0.9286	275	0.9175
156	0.9624	186	0.9509	216	0.9395	246	0.9283	276	0.9171
157	0.9620	187	0.9505	217	0.9391	247	0.9279	277	0.9168
158	0.9616	188	0.9501	218	0.9388	248	0.9275	278	0.9164
159	0.9612	189	0.9498	219	0.9384	249	0.9272	279	0.9160
160	0.9609	190	0.9494	220	0.9380	250	0.9268	280	0.9157
161	0.9605	191	0.9490	221	0.9376	251	0.9264	281	0.9153
162	0.9601	192	0.9486	222	0.9373	252	0.9260	282	0.9149
163	0.9597	193	0.9482	223	0.9369	253	0.9257	283	0.9146
164	0.9593	194	0.9478	224	0.9365	254	0.9253	284	0.9142
165	0.9589	195	0.9475	225	0.9361	255	0.9249	285	0.9138
166	0.9585	196	0.9471	226	0.9358	256	0.9245	286	0.9135
167	0.9582	197	0.9467	227	0.9354	257	0.9242	287	0.9131
168	0.9578	198	0.9463	228	0.9350	258	0.9238	288	0.9127
169	0.9574	199	0.9460	229	0.9346	259	0.9234	289	0.9124
170	0.9570	200	0.9456	230	0.9343	260	0.9231	290	0.9120
171	0.9566	201	0.9452	231	0.9339	261	0.9227	291	0.9116
172	0.9562	202	0.9448	232	0.9335	262	0.9223	292	0.9113
173	0.9559	203	0.9444	233	0.9331	263	0.9219	293	0.9109
174	0.9555	204	0.9441	234	0.9328	264	0.9216	294	0.9105
175	0.9551	205	0.9437	235	0.9324	265	0.9212	295	0.9102
176	0.9547	206	0.9433	236	0.9320	266	0.9208	296	0.9098
177	0.9543	207	0.9429	237	0.9316	267	0.9205	297	0.9094
178	0.9539	208	0.9425	238	0.9313	268	0.9201	298	0.9091
179	0.9536	209	0.9422	239	0.9309	269	0.9197	299	0.9087

TABLE 2—Continued

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 reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
300	0.9083	330	0.8974	360	0.8866	390	0.8760	420	0.8654
301	0.9080	331	0.8971	361	0.8863	391	0.8756	421	0.8651
302	0.9076	332	0.8967	362	0.8859	392	0.8753	422	0.8647
303	0.9072	333	0.8963	363	0.8856	393	0.8749	423	0.8644
304	0.9069	334	0.8960	364	0.8852	394	0.8746	424	0.8640
305	0.9065	335	0.8956	365	0.8848	395	0.8742	425	0.8637
306	0.9061	336	0.8952	366	0.8845	396	0.8738	426	0.8633
307	0.9058	337	0.8949	367	0.8841	397	0.8735	427	0.8630
308	0.9054	338	0.8945	368	0.8838	398	0.8731	428	0.8626
309	0.9050	339	0.8942	369	0.8834	399	0.8728	429	0.8623
310	0.9047	340	0.8938	370	0.8831	400	0.8724	430	0.8619
311	0.9043	341	0.8934	371	0.8827	401	0.8721	431	0.8616
312	0.9039	342	0.8931	372	0.8823	402	0.8717	432	0.8612
313	0.9036	343	0.8927	373	0.8820	403	0.8714	433	0.8609
314	0.9032	344	0.8924	374	0.8816	404	0.8710	434	0.8605
315	0.9029	345	0.8920	375	0.8813	405	0.8707	435	0.8602
316	0.9025	346	0.8916	376	0.8809	406	0.8703	436	0.8599
317	0.9021	347	0.8913	377	0.8806	407	0.8700	437	0.8595
318	0.9018	348	0.8909	378	0.8802	408	0.8696	438	0.8592
319	0.9014	349	0.8906	379	0.8799	409	0.8693	439	0.8588
320	0.9010	350	0.8902	380	0.8795	410	0.8689	440	0.8585
321	0.9007	351	0.8899	381	0.8792	411	0.8686	441	0.8581
322	0.9003	352	0.8895	382	0.8788	412	0.8682	442	0.8578
323	0.9000	353	0.8891	383	0.8784	413	0.8679	443	0.8574
324	0.8996	354	0.8888	384	0.8781	414	0.8675	444	0.8571
325	0.8992	355	0.8884	385	0.8777	415	0.8672	445	0.8567
326	0.8989	356	0.8881	386	0.8774	416	0.8668	446	0.8564
327	0.8985	357	0.8877	387	0.8770	417	0.8665	447	0.8560
328	0.8981	358	0.8873	388	0.8767	418	0.8661	448	0.8557
329	0.8978	359	0.8870	389	0.8763	419	0.8658	449	0.8554

TABLE 2—Continued

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 reducing oil volumes to the basis of 60°F.

t	M	t	M	t	M	t	M	t	M
450	0.8550	**460**	0.8516	**470**	0.8481	**480**	0.8447	**490**	0.8413
451	0.8547	**461**	0.8512	**471**	0.8478	**481**	0.8444	**491**	0.8410
452	0.8543	**462**	0.8509	**472**	0.8474	**482**	0.8440	**492**	0.8406
453	0.8540	**463**	0.8505	**473**	0.8471	**483**	0.8437	**493**	0.8403
454	0.8536	**464**	0.8502	**474**	0.8468	**484**	0.8433	**494**	0.8399
455	0.8533	**465**	0.8498	**475**	0.8464	**485**	0.8430	**495**	0.8396
456	0.8529	**466**	0.8495	**476**	0.8461	**486**	0.8427	**496**	0.8393
457	0.8526	**467**	0.8492	**477**	0.8457	**487**	0.8423	**497**	0.8389
458	0.8522	**468**	0.8488	**478**	0.8454	**488**	0.8420	**498**	0.8386
459	0.8519	**469**	0.8485	**479**	0.8451	**489**	0.8416	**499**	0.8383

CONSTRUCTION METHODS

2.10 Preparation of Road Surface:

Where the course is to be placed on a prepared base, the shoulders of the road shall have been completed for the full width of roadway prior to application of priming material. The surface to be covered shall be swept clean and free from dust, dirt, caked clay and loose foreign materials by means of revolving brooms or other approved methods. Particular care shall be taken to clean thoroughly the outer edges of the strip to be treated. Sweeping shall continue until all dust or loose dirt is removed and the top surfaces of the larger size aggregate on the surface of the base are exposed.

Where the course is to be placed on an existing pavement, the surface to be covered shall be swept clean of all dust, dirt and loose material before the application of the bituminous material.

2.11 Weather Limitations:

Bituminous materials shall not be applied during the calendar months of December, January and February. During the remainder of the year, bituminous materials shall not be applied on a wet base nor when the temperature of the air is less than 60°F in the shade.

2.12 Application of Primer:

The primer shall be applied to the prepared base and shall extend 6 inches beyond the width of surface treatment shown on the plans. The bituminous primer shall not be applied until the base has been compacted and bonded to the satisfaction of the engineer, 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 Article 2.14, "Application of Bituminous Material." If the course is to be constructed on an existing pavement, the pavement shall be primed, if so indicated on the plans or directed by the engineer.

When the prepared base consists of soil cement base course, and where the protective coating of emulsified asphalt has become worn or is otherwise insufficient, the contractor will be required to spot-prime the soil cement base course as directed by the engineer.

2.13 Patching and Repriming:

The prime coat shall be maintained intact and, if required by the engineer, the primed surface shall be thoroughly cleaned prior to the application of the wearing surface.

Where the prime coat has failed or depressions have occurred, the holes shall be swept clean and brush-coated with cutback asphalt and refilled with a mixture of aggregate and cutback asphalt which shall be thoroughly tamped so as to conform with the general crown and surface of the base. The aggregate used in the mixture shall be the same as used for cover material and shall be proportioned as directed by the engineer. Not less than 4 nor more than 6 per cent bituminous material by weight shall be used in the mixture. The materials used for patching shall be mixed in a manner satisfactory to the engineer and shall be allowed to cure for 2 days before being placed on the road. If, in the opinion of the engineer, the prime coat is generally unsatisfactory, the contractor shall be required to reprime the unsatisfactory surface.

2.14 Application of Bituminous Materials:

After the prime coat has been completed to the satisfaction of the engineer, bituminous material and mineral aggregate shall be applied in the amounts and in the sequence herein specified.

All bituminous material shall be applied uniformly for the full width of the treatment at one application 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 should be unable to keep the application of bituminous material consistently within 5 per cent of the quantity specified by the engineer, 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 applications within the allowable variations.

If one or more nozzles should become blocked during the application of the bituminous materials, the distributor should 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

of the 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 center line of the road, so as to assure complete coverage. 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 about empty. The distributor shall be equipped with a trough under the sprays, propertly arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread on the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned, however, no burning will be permitted on areas that have been newly seeded or sodded, or on any other grassy areas within the limits of the right of way.

Any excess of bituminous material 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 bituminous material directly from the distributor, shall be covered by means of a hand hose equipped with nozzles or by a hand pouring pot.

The contractor is hereby cautioned to exercise extreme care in heating bituminous materials to temperatures above flash points for the various types of asphalt.

2.15 Spreading Cover Material:

The aggregate shall be spread by the use of power spreaders or trucks equipped to distribute the aggregate, provided such trucks or spreaders do not drive on the uncovered asphalt. Where ½ the width of road is treated at a time, the aggregate shall be spread only to within 8 inches of the edge of the application along the center of the road until the bituminous material shall have been applied to the remaining portion of the road.

The spreading of aggregate shall at all times follow immediately the application of bituminous material. Im-

mediately after spreading, as many men as are necessary, equipped with hand brooms, shall broom off all high spots. The surface shall then be dragged with a broom drag.

2.16 Rolling Cover Material:

Immediately after spreading and brooming 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 and placed where necessary in such quantity as to completely cover the bituminous surface. Rolling, brooming, and spotting of additional cover material shall be continued until a uniformly closed surface has been obtained. The remaining courses shall be rolled the same as specified for the first course.

If clam shell aggregate is provided for cover material, the first course of coarse aggregate (Whole Clam Shell) shall be thoroughly rolled with a pneumatic-tired roller, loaded so as not to cause perceptible crushing. The second course of fine aggregate (Whole Clam Shell) shall be rolled and crushed in place as directed by the engineer by means of a steel wheel roller, weighing not less than 5 tons nor more than 10 tons, with the engineer reserving the right to specify either a 5-ton roller or a 10-ton roller or both. In the event the third course of seal coat aggregate consists of crushed clam shell, it shall be rolled with a pneumatic-tired roller. If whole clam shell is used for seal coat aggregate, it shall be crushed in place by rolling with a steel wheel roller of sufficient weight to crush the shell. After crushing and rolling with the steel wheel roller, the seal course shall be rolled with a pneumatic-tired roller.

2.17 Finishing:

The finished surface shall be uniform and shall conform to the lines, grades and typical cross sections shown on the plans, and when tested with templet and a 10-foot straightedge shall not vary more than ⅜ inch from the approved cross section and grade. The templet and straightedge shall be furnished by the contractor. Such portions

of the completed surface as are defective, or do not comply in all respects with the requirements of these specifications, shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications and at the expense of the contractor.

2.18 Protection:

Traffic should not be allowed to use the road, except as hereinafter provided, until the final application has been placed and thoroughly rolled.

After the prime coat has been applied, and unless it is impractical to detour highway traffic, the contractor shall keep all traffic off the road until, in the opinion of the engineer, the bituminous material has penetrated and dried out so as to not pick up under traffic.

In cases where traffic is permitted by the engineer, the contractor shall spread the minimum necessary amount of approved cover material over the bituminous primer to avoid its "picking up."

During the period that brooming and rolling may have been necessary, the contractor shall respread the seal coat aggregate that may be swept to the sides by traffic. This respreading shall be done with shovels, hand brooms or revolving brooms, if and when directed by the engineer, so as to prevent "bleeding," and to avoid the possibility of the bituminous seal coat "picking up" under traffic. If the repeated respreading of the seal coat aggregate is inadequate for this purpose and the engineer so directs, the contractor shall spread additional seal coat aggregate as may be necessary to prevent "bleeding" and "picking up."

MEASUREMENT AND PAYMENT

2.19 Method of Measurement:

The quantities of aggregate and bituminous material entering into the completed and accepted bituminous surface treatment will be measured separately. Aggregate will be measured by the cubic yard and bituminous material will be measured by the gallon.

The number of cubic yards of aggregate placed and accepted, shall be determined by measurement in vehicles at the point of placing on the road in accordance with Article 9.01, Division I.

The number of gallons of bituminous material placed and accepted, will be measured by the gallon of 231 cubic inches and shall be measured in the distributor. Measurement shall be made at a temperature of 60°F or converted to gallonage at 60°F in accordance with "Temperature-Volume Correction Tables for Asphaltic Materials," as set forth in Article 2.09.

When the prepared base course consists of soil cement base course, bituminous primer required to spot-prime the base, as directed by the engineer, will be measured and such measurement shall be made under the bituminous material item used in the construction of the wearing course.

2.20 Basis of Payment:

The number of cubic yards of aggregate and the number of gallons of bituminous material, measured as provided above shall be paid for at the contract unit prices for the several items complete in place, which prices and payments shall constitute full compensation for furnishing all material, all tools, labor, equipment and incidentals and the performance of all work necessary to complete the item and for all royalties and payments whatsoever for patents covering processes or equipment used in constructing the item.

When the prepared base consists of soil cement base course, bituminous primer that may be required by the engineer to spot-prime the soil cement base shall be paid for and such payment will be made under the bituminous material item used in the construction of the wearing course.

Payment will be made under:

Item 3-2-1, Bituminous Primer, Cutback, per gallon.

Item 3-2-2, Bituminous Primer, Grade EA-5, per gallon.

Item 3-2-3, Asphalt Cement, per gallon.

Item 3-2-4, Cutback Asphalt, per gallon.

Item 3-2-5, Emulsified Asphalt, per gallon.

Item 3-2-6, Coarse Aggregate (Size 1), per cubic yard.

Item 3-2-7, Fine Aggregate (Size 2), per cubic yard.

Item 3-2-8, Seal Coat Aggregate (Size 3), per cubic yard.

Item 3-2-9, Clam Shell Aggregate, per cubic yard.

SECTION 3

BITUMINOUS MIXTURE FOR HOT APPLICATION

3.01 Description:

This item shall consist of a binder course, wearing course, or a combination of these courses, each consisting of a mixture of mineral aggregate and bituminous material applied hot on the prepared base, in accordance with these specifications and in conformity with the lines, grades, and typical cross sections shown on the plans.

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 3 types:

Type 1 mix shall be composed of crushed gravel, crushed stone, crushed slag, or a combination of these materials, sand, mineral filler and bituminous material.

Type 2 mix shall be composed of whole clam shell, crushed clam shell, or a combination thereof, sand, mineral filler and bituminous material.

Type 3 mix shall be composed of crushed limestone rock asphalt and gravel, crushed stone, crushed slag, or a combination of these materials, sand, mineral filler and bituminous material.

3.02 Composition and Proportioning:

Bituminous mixture furnished for binder course shall be either Type 1 mix or Type 2 mix. If both types are indicated on the plans, the type selected for use on the project shall be as the contractor elects, however, the same type mix shall be used for binder course throughout the project.

Bituminous mixture furnished for wearing course may be either Type 1 mix, Type 2 mix or Type 3 mix. If more than one type is indicated on the plans, the type selected for use on the project shall be as the contractor elects, however the same type mix shall be used for wearing course throughout the project.

The mineral aggregate and bituminous material in the various type mixtures shall be combined in such proportions that the mixture shall meet the following requirements by weight:

Material	Binder Course		Wearing Course	
	Min.	Max.	Min.	Max.
Type 1				
Total Mineral Aggregate, %	94.0	96.0	93.5	95.5
Total Bitumen, %	4.0	6.0	4.5	6.5
Type 2				
Total Mineral Aggregate, %	92.5	95.0	92.0	94.0
Total Bitumen, %	5.0	7.5	6.0	8.0
Type 3				
Total Mineral Aggregate, %	.....	.....	93.5	95.5
Total Bitumen, %	.....	.....	4.5	6.5

Mineral Aggregates: Mineral aggregates furnished for the various type mixes shall meet the following requirements:

Type 1

The several mineral constituents of the mixture shall be so sized and graded and shall be combined in such proportions that the resulting composite blend will meet the grading requirements indicated below. In no event shall the fraction of mineral filler be less than 2 per cent of the mixture.

PER CENT PASSING

Sieve	Binder Course	Wearing Course
1¼"	100.0	100.0
1"	90 to 100	100.0
¾"	75 to 100	100.0
½"	55 to 80	85 to 100
No. 4	35 to 60	60 to 80
No. 10	25 to 45	40 to 60
No. 40	15 to 30	20 to 35
No. 80	8 to 18	12 to 25
No. 200	2 to 6	4 to 10

Type 2

The several mineral constituents of the mixture shall be combined in approximately the following quantities:

	Min.	Max.
Shell, %	70	80
Sand, %	20	30

The maximum size aggregate shall be as follows:

Binder Course, % Passing 1½" sieve	100
Wearing Course, % Passing ¾" sieve	100

The mineral aggregate shall be graded from coarse to fine. The intent of this specification is to provide a material graded from 1½ inch down for the binder course and from ¾ inch down for the wearing course. Not less than 4 nor more than 10 per cent of the composite aggregate shall pass the 200 mesh sieve. In no event shall the fraction of mineral filler be less than 2 per cent of the mixture.

Type 3

The limerock asphalt and mineral aggregate shall be so sized and graded and shall be combined in such proportions that the resulting composite blend will meet the grading requirements indicated below. The natural limestone rock asphalt constituent shall constitute not less than 30 per cent by weight of the total paving mixture. In no event shall the fraction of mineral filler be less than 2 per cent of the mixture.

Sieve	Per Cent Passing Wearing Course
¾"	100
½"	85 to 100
No. 4	50 to 75
No. 10	40 to 65
No. 40	15 to 35
No. 80	5 to 20
No. 200	3 to 10

To such composite blended aggregate (considered as 100 per cent), for Type 1 or Type 2 mixtures, bitumen shall be added within the percentage limits indicated hereinbefore for either the binder course or wearing course.

To such composite blended aggregate (considered as 100 per cent), for Type 3 mixture, additional bitumen shall be added so that the total bitumen content of the mix shall be within the percentage limits indicated hereinbefore.

3.03 Formula for Job Mix:

The general composition limits prescribed herein are extreme ranges of tolerance that shall not be exceeded regardless of any formula that may be submitted or set up notwithstanding tolerances specified below.

Before beginning the work, samples of the materials the contractor proposes to use shall be submitted by the engineer to the laboratory. The contractor may, at his option, submit to the engineer a proposed formula, in writing, for the mixture to be supplied for the project. If a formula is submitted it shall stipulate a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, a single definite percentage of natural limestone rock asphalt in the event this type mixture is used, and a single definite temperature at which the mixture is to be delivered on the road. The engineer shall then set the job mix based on either the submitted formula or on the material samples furnished. In setting the job mix, the engineer at his discretion may use the submitted formula, in whole or in part. In any event, the job-mix formula shall fix a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, a single definite percentage of natural limestone rock asphalt in the event this type mixture is used, and a single definite temperature at which the mix is to be delivered on the road. The job-mix formula, however established, shall after processing result in a dense mix and a satisfactory gradation by extraction.

3.04 Application of Job-Mix Formula and Allowable Tolerances:

After the job-mix formula is established as prescribed above, each aggregate size and the percentage of bitumen

furnished for the project shall conform thereto within the following ranges of tolerances:

	Type 1	Type 2	Type 3
	Percentages—plus or minus		
Passing No. 4 and for Larger Sieves	7.0	7.0	7.0
Passing No. 10 to No. 80 Sieves, inclusive	5.0	5.0	5.0
Passing No. 200 Sieve	2.0	2.0	2.0
Bitumen	0.1	0.1	0.1
	Degrees F—minus		
Temperature of Mixture on Delivery	25	25	25

Each day the engineer shall take as many samples as he considers necessary for checking the uniformity of the mixture. When unsatisfactory results or changed conditions make it necessary, the engineer may establish a new job-mix formula.

Should a change in sources of materials be made, a new job-mix formula shall be established before the mixture containing the new materials is produced.

3.05 Physical Properties of Mixture:

Compacted specimens of the mixture, either prepared in the mixing plant during construction or in the laboratory, shall conform to the following properties:

(1) The stability value at 140°F shall be not less than 1,000 pounds;
(2) The flow value, when measured in 1/100 graduations, shall be not less than 8 nor more than 18;
(3) The per cent of theoretical density shall be not less than 94 nor more than 98.

The methods for preparing laboratory mixtures, test specimens, and performing the tests shall be as described in the pamphlet titled "Marshall Stability Method for the Design and Control of Asphalt Paving Mixtures," with subsequent revisions to date.

3.06 Tack Coat:

Before constructing the binder course or wearing course, a tack coat of the width indicated on the plans

shall be applied to the prepared base at the rate specified by the engineer but not to exceed 0.10 gallon per square yard. When the bituminous mixture is placed on an asphalt surface, the tack coat may be decreased or eliminated if directed by the engineer. The responsibility for the protection of the tack coat shall rest with the contractor and spot patching required shall be made at no extra cost.

Tack coat may be either cutback asphalt, Grades RC-1 or RC-2, or emulsified asphalt, Grades EA-1 or EA-2, as the contractor elects. Asphalt for tack coat shall meet the requirements of Article 3.10.

3.07 Plant and Machinery:

All plants used by the contractor for the preparation of the mixture shall conform to all the requirements herein. Only batching plants will be permitted.

Sufficient storage space shall be provided for separate stock piles, bins, or stalls for each size of aggregate, and the different aggregate sizes shall be kept separated until they have been delivered by the feeder or feeders to the boot of the cold elevator in their proper proportions. The storage yard shall be maintained neat and orderly and the separate stock piles shall be kept readily accessible for sampling. Stock piles shall be leveled when and as directed by the engineer.

(1) Uniformity: The plant shall be so designed, coordinated, and operated as to produce a mixture within the job-mix tolerances fixed by the contract.

(2) Scales: Scales for any weigh box or hopper may be either the beam or springless dial type and shall be of a standard make and design, accurate to ½ of one per cent of the maximum load that may be required.

When scales are of the beam type, there shall be a separate beam for each size of aggregate. There shall be provided a "telltale" dial that will start to function when the load being applied is within 100 pounds of that desired. Sufficient vertical movement shall be provided for the beams to permit the "telltale" dial to function properly. Each beam shall have a locking device designed and so located that the beam can easily be suspended or thrown into action. The weighing mechanism shall be balanced on knife edges and fulcrums and shall be so constructed that it cannot be easily thrown out of alignment and adjustment.

Dial scales shall be springless, of a standard make, and of such size that the numerals on the dial can be read at a distance of at least 25 feet. The dials shall be of the compounding type having full complements of index pointers. Pointers so placed as to give excessive parallax errors shall not be used. The scales shall be substantially constructed, and those that easily get out of adjustment shall be replaced with other makes when so ordered. All dials shall be so located as to be plainly visible to the operator at all times.

Scales used for the weighing of bituminous material shall conform to the specifications for the scales for aggregate except that each beam scale shall be equipped with a tare beam and a full capacity beam. The value of the minimum graduation shall not be greater than 2 pounds. Dial scales for weighing the bituminous material shall not have a capacity of more than twice the weight of the material to be weighed and shall read to the nearest pound. Beam scales shall be equipped with a "telltale" device which will start to function when the load being applied is within 10 pounds of that desired.

Scales shall be satisfactory to the engineer and shall be sealed as often as the engineer may deem it necessary to insure their accuracy. The contractor shall provide and have at hand the necessary number of standard test weights for frequent testing of all scales.

(3) Equipment for Preparation of Bituminous Material: Tanks for storage of bituminous material shall be capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks. Heating shall be accomplished by steam coils, electricity, or other means so that no flame shall come in contact with the heating tank. The circulating system for bituminous material shall be of adequate size to insure proper and continuous circulation during the entire operation period. All pipe lines and fittings shall be steam-jacketed or otherwise properly insulated to prevent heat loss. Storage tank capacity shall be sufficient for at least one day's run.

(4) Feeder for Drier: The plant shall be provided with an accurate mechanical means for uniformly feeding

the mineral aggregate into the drier so that uniform production and uniform temperature will be obtained.

The feeder or feeders shall be mechanically operated, of the apron reciprocating type or vibrating type with accurate and separate adjustments for total and proportional feed. The adjustments for total and proportional feed shall be continuously variable and capable of being locked in any position. The feeder or feeders shall be capable of delivering the maximum number of aggregate sizes required in their proper proportions. Mixing on the ground of the various aggregate sizes will not be permitted at any time.

(5) Drier: A rotary drier of any satisfactory design for drying and heating the mineral aggregate shall be provided. The drier shall be capable of drying and heating the mineral aggregate to specification requirements.

(6) Screens: Plant screens, capable of screening all aggregates to the specified sizes and having normal capacities slightly in excess of the full capacity of the mixer, shall be provided.

(7) Bins: The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be divided into at least 3 compartments arranged to insure separate and adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such a location as to prevent any backing up of material into other bins.

Adequate dry storage shall be provided for the mineral filler and provisions made for proportioning the filler for each batch of mixture.

(8) Bituminous Control Units: Satisfactory means for weighing shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified for the job mix. Suitable means shall be provided, either by steam-jacketing or other insulation, for maintaining the specified temperature of bituminous material in the pipe lines, weigh buckets, spray bars and other containers or flow lines.

(9) Thermometric Equipment: An armored thermometer reading from 200°F to 400°F shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit.

The plant shall be further equipped with an approved mercury thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register or indicate automatically the temperature of the heated aggregates.

The engineer reserves the right to pass upon the efficiency of thermometric instruments and, for better regulation of the temperature of aggregates, may direct replacement of any instrument by some approved temperature-recording apparatus and may further require that daily temperature charts be filed with him.

(10) Control of Mixing Time: The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time unless changed by order of the engineer. The time of mixing shall be considered as the interval between the time the bituminous material is spread on the aggregate and the time the mixture leaves the mixing unit.

(11) Weigh Box or Hopper: The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over of the aggregate. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alignment or adjustment. All edges, ends, and sizes of weighing hoppers shall be free from contact with any supporting rods or columns or other equipment that will in any way affect proper functioning of the hopper. Also, there must be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials. The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

(12) Mixer Unit: The plant shall include a batch mixer of an approved twin pugmill type or a rotary drum type, steam-jacketed, and capable of producing a uniform mixture within the job-mix tolerances fixed by the contract.

3.08 Equipment:

All equipment necessary for the proper construction of this work shall be in satisfactory condition and shall have

been approved by the engineer before construction begins. The equipment shall be maintained in a satisfactory working condition and shall consist essentially of the following:

1. A power revolving broom or power blower.
2. Distributors meeting the requirements set forth under "Equipment" in Article 2.03, Part 3, Division II.
3. A finishing machine capable of spreading, leveling and finishing the mixture in one continuous operation.
4. Rollers consisting of 10-ton tandem rollers and 10-ton three-wheel rollers. The rollers shall be capable of reversing without backlash. When necessary to obtain the required degree of compaction, additional rollers of an approved design shall be furnished.

MATERIALS

3.09 Aggregate:

(a) Type 1 Mixture: The aggregate shall consist of crushed gravel, crushed stone, crushed slag, or a combination of these materials conforming to the gradation requirements contained in Article 3.02.

Crushed gravel shall consist of clean, hard, tough, durable stone fragments and shall be screened and crushed to size as necessary to meet the grading requirements specified herein. At least 60 per cent of the gravel retained on a 10-mesh sieve shall have one or more crushed faces. Gravel shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter. Crushed stone shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed slag shall be air-cooled, blast furnace slag, and shall consist of angular fragments reasonably free from flat or elongated pieces, dirt or other objectionable matter. Crushed slag shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. The slag shall not contain more than 10 per cent by weight of glassy particles and the crushed slag shall have a weight per cubic foot of not less than 70 pounds using the Method of Test for Unit Weight of Aggregates, A.A.S.H.O. Designation: T 19.

Sand shall consist of clean, hard durable grains graded from coarse to fine, free from clay coating and clay lumps, vegetable matter or other deleterious substance. The fraction passing the 40 mesh sieve shall have a plastic index not exceeding 2 when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87.

The mineral filler shall be a commercial filler which may consist of limestone dust, shell dust, silica dust or Portland cement, shall be non-plastic and shall meet the following gradation requirements:

U. S. Standard Sieve	Grain Size mm.	Proposed Limits Per Cent Finer
	0.590	100
No. 30	0.177	95 to 100
No. 80	0.074	65 to 100
No. 200	0.050	60 to 100
.....	0.020	30 to 60
.....	0.005	10 to 25
.....	0.001	2 to 15
.....		

The gradation of the larger grain sizes of mineral filler will be determined by the Method of Test for Sieve Analysis of Mineral Filler, A.S.T.M. Designation: D 546, using No. 30, No. 80, and No. 200 mesh sieves. The gradation of the materials finer than 0.074 mm. or passing a No. 200 sieve will be determined by the Methods of Mechanical Analysis of Soils, A.A.S.H.O. Designation: T 88 (The Hydrometer Test).

The moisture content of the aggregate at the time of mixing shall not exceed ½ per cent by weight.

(b) Type 2 Mixture: The aggregate shall consist of whole clam shell, crushed clam shell, or a combination thereof, conforming to the gradation requirements contained in Article 3.02.

Shell shall consist of dead clam shell. The shell shall be 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 per cent by weight when dry, provided such material is dispersed throughout the mass.

Sand and mineral filler shall meet the requirements for these materials contained hereinabove under (a), "Type 1 Mixture."

The moisture content of the aggregate at the time of mixing shall not exceed ½ per cent by weight.

(c) Type 3 Mixture: The aggregate shall consist of crushed limestone rock asphalt and gravel or crushed stone, or crushed slag, or a combination of these materials, conforming to the gradation requirements contained in Article 3.02.

The limestone rock asphalt shall be crushed natural asphaltic limestone. The asphaltic limestone shall consist of limestone rock which has been impregnated by the forces of nature with not less than 2 per cent of bitumen nor more than 98 per cent of limestone, practically free from dirt, decomposed rock and other foreign matter. The native asphalt in the rock shall have a penetration of not less than 6 nor more than 100. The limestone shall be crushed so that when tested with laboratory sieves it shall conform to the following gradation requirements:

Sieve	Per Cent Passing
⅜"	90 to 100
No. 10	50 to 85
No. 200	4 to 15

Limestone shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Gravel shall consist of clean, hard, tough, durable stone fragments. Gravel shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed stone, crushed slag, sand and mineral filler shall meet the requirements for these materials contained hereinabove under (a), "Type 1 Mixture."

The moisture content of the aggregate at the time of mixing shall not exceed ½ per cent by weight.

(d) General: Aggregates furnished under Type 1 or Type 2 or Type 3 mix, as the case may be, which are found to have voids or other characteristics requiring,

for a balanced mix, a bitumen content in excess of or less than the bitumen content range specified in these specifications, shall be rejected.

3.10 Asphalt for Tack Coat:

Tack coat may be either Grade RC-1 Cutback Asphalt, Grade RC-2 Cutback Asphalt, Grade EA-1 Emulsified Asphalt, or Grade EA-2 Emulsified Asphalt, as the contractor elects.

(a) Cutback Asphalt: Cutback asphalt shall be free from water and shall show no separation or curdling prior to use. Grades RC-1 and RC-2 cutback asphalt shall meet the requirements for same contained in Article 2.07, Part 3, Division II.

Testing of cutback asphalt for tack coat shall be in accordance with said article.

(b) Emulsified Asphalt: Emulsified asphalt shall be homogeneous and show no separation of asphalt after thorough mixing, within 30 days after delivery, provided separation was not caused by freezing. Grade EA-2 emulsified asphalt shall meet the requirements for same contained in Article 2.08, Part 3, Division II. Grade EA-1 emulsified asphalt shall meet the following requirements:

GRADE EA-1

	Min.	Max.
Viscosity, Saybolt Furol, @ 77°F, sec.	20	100
Residue by Distillation, %	55	60
Settlement, 10 days, %	.....	3
Demulsibility, 35 ml. of 0.02 N, $CaCl_2$, %	75	.....
Sieve Test, %	.....	.05
Test on Residue from Distillation:		
Penetration @ 77°F, 100g, 5 sec.	100	200
Soluble in CS_2	97	.....
Loss @ 325°F, 5 hrs., %	.....	1.0
Ductility @ 77°F, cm.	60	.....
Ash	.....	2

Sampling and Method of Testing shall be in accordance with Article 2.08, Part 3, Division II.

3.11 Asphalt Cement for Bituminous Mixture:

The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 347°F and shall conform to the following requirements:

GRADE AC-5

	Min.	Max.
Penetration @ 77°F, 100g, 5 sec.	85	100
Flash Point, C.O.C., °F	347	.....
Loss @ 325°F, 50g, 5 hrs., %	.....	1
Penetration of Residue @ 77°F, 100g, 5 sec., Percentage of Original Penetration	65	.....
Bitumen Soluble in CS_2, %	99.5	.....
Ductility @ 77°F, cm.	100	.....
Homogeneity	Negative	

Testing of asphalt cement shall be in accordance with the requirements for testing asphalt cement contained in Article 2.06, Part 3, Division II, and as hereinafter provided.

In order to prevent contamination of the asphalt cement during shipment, or to pick up any error that might be due to shipment of the wrong grade of material, the contractor will be required to handle asphalt cement for use on the project in the following manner.

In addition to working tanks provided in paragraph (3) of Article 3.07, the contractor shall provide an on-the-site storage tank having a minimum capacity of 10,000 gallons. All asphalt cement delivered to the plant site shall be unloaded from the truck or car into the storage tank. Delivery of asphalt cement directly into working tanks is prohibited.

The material accumulated in the storage tank will be tested for penetration at 77°F and for Cleveland Open Cup Flash and approved by the engineer before transfer may be made to the contractor's working tanks. Spot check samples will be taken periodically for a complete analysis for check against the refinery analysis.

Samples which when tested show contamination or do not conform to specification requirements will be cause for rejection of the material.

Tests for Cleveland Open Cup Flash shall be conducted in accordance with the Method of Test for Flash and Fire Points by Means of Open Cup, A.S.T.M. Designation: D 92.

Tests for Penetration shall be conducted in accordance with the Method of Test for Penetration of Bituminous Materials, A.S.T.M. Designation: D 5.

3.12 Sources of Supply:

Approval of sources of supply of limerock asphalt, aggregate and mineral filler shall be obtained from the engineer prior to delivery of materials. Samples of each material shall be submitted as directed.

The contractor shall furnish for testing, when required by the engineer, 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.

3.13 Field Laboratory:

For each bituminous mixing plant, the contractor shall provide a suitable building, room, or portable trailer for use as an office and for testing purposes and to be used exclusively by the engineer or his inspectors. The laboratory shall be so located that details of all plant operations are plainly visible from one window of the field laboratory.

The field laboratory, upon completion of the project, shall remain the property of the contractor.

CONSTRUCTION METHODS

3.14 Weather Limitations:

Bituminous mixtures and/or materials shall not be applied on a wet base, nor when the weather is foggy or rainy. Bituminous mixtures shall not be applied during the calendar months of December, January and February. During the remainder of the year, placing of bituminous mixtures shall be discontinued when a descending air temperature in the shade and away from artificial heat falls below 40°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 36°F.

3.15 Preparation of Road Surface:

The shoulders shall have been completed for the full width of roadway prior to application of tack coat. The surface to be covered shall be swept clean and free from all dust and dirt, caked clay and loose foreign material by means of revolving brooms or other approved mechanical sweepers supplemented by hand brooms. Sweeping shall continue until all dust or loose dirt is removed and the surfaces of the larger sized aggregate in the base are exposed.

Where the bituminous mixture is to be placed on an existing concrete pavement slab, the contractor shall, in addition to cleaning the surface as required above for aggregate type bases, remove all joint filler from the surfaces of the slab, including such additional joint filler that may be placed for the maintenance of the existing slab when required by the plans and/or special provisions. Joint filler placed for maintenance purposes shall be asphalt mineral filler conforming to the applicable requirements of Section 5, Part 3, Division II. Complying with these requirements will in no way relieve the contractor from maintaining the existing pavement so as to prevent as much water as possible from reaching the subgrade.

Contact surfaces of curb, gutters, manholes and other structures shall be painted with a thin uniform coating of hot asphalt cement just before the bituminous mixture is placed against them.

The condition of the base shall be approved by the engineer prior to the placing of the mixture.

3.16 Application of Tack Coat:

Before the bituminous mixture is placed, a tack coat shall be applied to the prepared base in accordance with Article 2.14, Part 3, Division II. The extent of the application placed in advance of the bituminous mixture shall be at the discretion of the engineer.

3.17 Preparation of Bituminous Material and Aggregate:

The bituminous material, aggregate and/or limerock asphalt shall be prepared by mixing at a central mixing point. At the time of mixing the aggregate and/or asphaltic limestone shall be heated to a temperature of not less than 250°F and not more than 350°F.

Grade AC-5 asphalt cement shall be heated to a temperature of not less than 250°F and not more than 325°F.

The bituminous mixture, when discharged from the mixer, shall be at a temperature of from 250°F to 325°F.

3.18 Preparation of Mixture:

The dried mineral aggregate for any of the various type mixtures shall be combined in the plant in the proportionate amount of each fraction of aggregate required to meet the job-mix formula. The engineer shall determine the quantity of bituminous material for each batch. In any case, the bituminous material shall be measured or gauged and introduced into the mixer in the proportionate amount to be determined by the engineeer for the particular material being used. Prior to adding bituminous material, the combined mineral aggregate shall be thoroughly mixed dry, after which the proper amount of bituminous material shall be distributed over the mineral aggregate and the whole thoroughly mixed for a period of 45 seconds or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated. In any event, the mixing time shall be regulated by the engineer and suitable locking means shall be provided for such regulation.

3.19 Forms:

The use of forms will not be required. However, the edges of the pavement shall be accurately aligned by the use of string or wire lines or any other suitable method approved by the engineer.

3.20 Transporting and Delivery of Mixtures:

Bituminous mixtures, heated and prepared as specified, shall be transported from the mixing plant to the site of the work in vehicles previously cleaned of all foreign materials and having tight bodies. When directed by the engineer, each load shall be covered with canvas or other suitable material of such size and thickness to protect it from the weather. 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 satisfactory to the engineer is provided. The mixture shall be delivered at a temperature of from 250°F to 325°F.

3.21 Spreading and Finishing:

Upon arrival at the point of use, the mixture shall be spread and struck off to the profile grade, elevation and cross section indicated on the plans for each course. For this purpose, self-powered spreading and finishing equipment provided with a screed or strike-off assembly shall be used, distributing the mixture either over the entire width or over such partial width lanes as may be practicable. Blade graders or drags shall not be used. The assembly shall be adjustable to give the cross section shape prescribed and shall be so designed and operated as to place the weight per square yard of surfacing material required.

If during construction it is found that the spreading and finishing equipment in operation leaves in the new surface course tracks or indented areas that are not satisfactorily corrected by the scheduled operations, or if it produces other permanent blemishes, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the contractor.

The term "screed" includes any cutting, crowding, or other practical action that is effective in producing, from the mixture specified, without tearing, shoving, or gouging, a finished surface of the evenness and texture specified.

On the areas where irregularities or unavoidable obstacles make the use of the self-powered spreading and finishing equipment impracticable, in the judgment of the engineer, the mixture shall be spread and screeded by hand. On such areas the mixture shall be dumped on steel dump boards and spread and screeded to leave the weight of material required.

The contractor shall provide suitable means for keeping all small tools clean and free from accumulations of bituminous material. He shall provide and have ready for use at all times enough tarpaulins or covers, as may be directed by the engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may be dumped and not spread.

3.22 Compaction:

After the spreading and striking off and while still hot, each course shall be thoroughly and uniformly compacted by rolling. The contractor shall furnish both a three-wheel

roller and a tandem roller. A sufficient number of rollers shall be furnished on the work to provide one roller for each 50 tons of bituminous mixture laid per hour. Additional types of rollers may be required as necessary to meet the compaction and smoothness requirements specified herein.

Rolling shall be conducted in a manner and by methods that will obtain the density and smoothness requirements hereinafter specified. Each roller shall be operated by a competent, experienced roller operator and, while the work is under way, shall be kept as nearly as practicable in continuous operation. Rolling shall begin at the sides and progress gradually to the center, except that on superelevated curves rolling may progress from the lower to the upper edge parallel with the center line of the road and uniformly lapping each preceding track, as directed by the engineer, until the entire surface has been rolled by the rear wheels. Rolling shall be continued until all roller marks are eliminated and a roadway density of at least 92 per cent of maximum theoretical density has been obtained, or, when tested by standard methods of the Department's laboratory, shall not have in excess of 8 per cent voids. 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 the reversing of the direction of the roller, or from any other cause, shall be corrected at once by the use of rakes and of fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water or oil will not be permitted.

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 with mechanical tampers to obtain the required density. Each hand tamper shall weigh not less than 25 pounds and shall have a tamping face area of not more than 50 square inches.

No surface course material shall be placed against the edge of a course or layer that has been rolled and has cooled, unless such edge is beveled or has been cut back to a slightly beveled face as directed by the engineer, and in either case has received a brush coat of asphalt.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt, or

in any way defective prior to the application of the finish coat shall be removed and replaced with fresh hot mixture, which shall be immediately compacted to conform with the surrounding area. Any area of one square foot or more showing an excess of bituminous material shall be removed and replaced.

3.23 Construction Joints:

The placing of the mixture shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued for such a length of time as to permit the mixture to become chilled. In all such cases, when the work is resumed, the material laid shall be cut back so as to produce a slightly beveled edge for the full thickness of the course. The old material which has been cut away shall be removed from the work and before placing additional mixture the existing cut shall be tack coated and the mixture laid against the fresh cut. Hot smoothing irons may be used for sealing the joints, but in such cases care shall be exercised to avoid burning the surface.

3.24 Surface Tolerance:

Before final acceptance, the wearing course shall be tested by a crown templet and by 3-foot and 10-foot straightedges applied at right angles and parallel, respectively, to the center line of the roadbed. The crown templet shall conform to the typical cross section shown the plans. The variation of the surface from the testing edge of the crown templet between any 2 contacts with the surface shall at no point exceed $\frac{3}{16}$ inch. The variation of the surface from the testing edges of the straightedges between any 2 contacts with the surface shall at no point exceed $\frac{3}{16}$ inch for the 10-foot straightedge or $\frac{1}{8}$ inch for the 3-foot straightedge.

Tests for conformity with the specified crown and grade shall be made by the contractor immediately after initial compression, and variation shall be corrected by removing or adding materials as may be necessary. Rolling shall then be continued as specified. After application of the wearing course, and after final rolling, but before acceptance of the work, the smoothness of the course shall be checked

again and all humps or depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new material as specified.

The above requirements for surface tolerances shall apply to binder course materials when directed by the engineer.

3.25 Protection of Pavement:

Sections of newly finished pavement shall be protected from traffic until they have been properly hardened by cooling. Traffic shall be excluded from the newly laid mixture for a period of 6 hours after completion of rolling, unless otherwise permitted by the engineer.

MEASUREMENT AND PAYMENT

3.26 Method of Measurement:

Bituminous hot mix shall be measured by either of the following methods, as shown on the plans or in the special provisions.

Mineral aggregates and bitumen will be measured separately as follows:

Mineral aggregates (including limerock asphalt if this material is used) for bituminous mixtures (binder course and/or wearing course) will be measured by the ton of 2,000 pounds, complete in place.

Bitumen for bituminous mixtures (binder course and/or wearing course) will be measured by the ton of 2,000 pounds, complete in place.

Or, bituminous mixtures (combined mix) (binder course and/or wearing course) will be measured by the ton of 2,000 pounds, complete in place.

The tonnage of the various materials shall be determined from plant batch weights with deductions for all materials lost, wasted, damaged, rejected or applied in excess of the engineer's directions or contrary to these specifications.

Bituminous tack coat will be measured by the gallon of 231 cubic inches, complete in place. The gallonage of asphalt material to be paid for shall be the number of gallons used as ordered in the accepted tack coat. Gallonage shall be determined by measuring the material at a temperature of 60°F, or by converting the gallonage measured at other temperatures to gallonage at 60°F, in

accordance with the "Temperature-Volume Correction Tables for Asphaltic Materials" as set forth in Article 2.09, Part 3, Division II.

3.27 Basis of Payment:

The quantity of material placed and accepted, measured as provided above, shall be paid for at the contract price per unit for each of the various materials incorporated in the completed and accepted work, which prices and payments shall constitute full compensation for furnishing all materials including any additional asphalt mineral filler that may be required for the maintenance of existing concrete pavement; for all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item and for all royalties and payments whatsoever for patents covering processes or equipment used in constructing the item.

Payment will be made under:

Item 3-3-1, Mineral Aggregate (Binder Course) per ton.

Item 3-3-2, Mineral Aggregate (Wearing Course), per ton.

Item 3-3-3, Bitumen, per ton.

Item 3-3-4, Bituminous Mixture for Hot Application (Binder Course), per ton.

Item 3-3-5, Bituminous Mixture for Hot Application (Wearing Course), per ton.

Item 3-3-6, Bituminous Tack Coat, per gallon.

SECTION 4

BITUMINOUS MIXTURE FOR COLD APPLICATION

4.01 Description:

This item shall consist of a binder course, wearing course, or a combination of these courses, each consisting of a mixture of mineral aggregate and bituminous material applied cold on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross sections shown on the plans.

These specifications cover the furnishing of either Type 1 or Type 2 mixtures, as follows:

Type 1 mix shall be composed of mineral aggregate and cutback asphalt.

Type 2 mix shall be composed of mineral aggregate, Portland cement, hydrated lime and emulsified asphalt.

4.02 Composition and Proportioning:

Bituminous mixture furnished for binder course or wearing course may be either Type 1 mix or Type 2 mix, as the contractor elects, however the same type shall be used for binder course or wearing course throughout the project.

For Type 1 mixtures, the mineral aggregate and bituminous material shall be combined in such proportions that the mixture shall meet the following requirements by weight:

Type 1

Material	Binder Course		Wearing Course	
	Min.	Max.	Min.	Max.
Total Mineral Aggregate, %	94.0	95.5	93.0	95.0
Total Residual Bitumen, %	4.5	6.0	5.0	7.0

For Type 2 mixtures, the mineral aggregate, Portland cement, hydrated lime and bituminous material shall be combined in such proportions that the mixture shall meet the following requirements by weight:

Type 2

Material	Binder Course		Wearing Course	
	Min.	Max.	Min.	Max.
Total Mineral Aggregate, %	92.3	94.4	91.3	93.9
Total Portland Cement, %	1.0	1.5	1.0	1.5
Total Hydrated Lime, %	0.1	0.2	0.1	0.2
Total Residual Bitumen, %	4.5	6.0	5.0	7.0

Volumetric proportioning may be substituted for weight proportioning. The mixer may be of the pugmill or drum type.

The percentage of bitumen may vary between the extreme limits herein set forth, however, the exact percentage will be fixed by the engineer, depending on the gradation and type of aggregate used.

If Type 1 mixture is furnished, the finished material is intended for immediate use upon arrival at destination and must be in a workable condition. This material is not intended for stock piling and shipment by railroad cars will not be permitted except during the calendar months of June, July and August. It must be used immediately when loaded directly from plant or cars.

If Type 2 mixture is furnished, the finished material is intended for use not less than 48 hours after processing. If shipped by railroad, it may be loaded immediately in railroad cars from the mixer. If intended for truck delivery, it shall be stock-piled at the supplier's plant for a period of not less than 48 hours. The material must be in a workable condition upon arrival at destination.

Before constructing the binder course or wearing course, a tack coat of cutback asphalt of the width indicated on the plans and meeting the requirements of RC-1 asphalt herein shall be applied to the prepared base at the rate not exceeding 0.10 gallon per square yard, as directed by the engineer. Where the bituminous mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the engineer.

4.03 Plant and Machinery:

The mixing plant used in the preparation of the bituminous material shall be stationary and shall comply with the following requirements:

The plant shall have a storage bin of sufficient capacity to furnish the necessary amount of aggregate up to the maximum rated capacity of the plant with no undue periods of waiting for material.

The drum or housing of the mixer shall be so constructed that leaking of the bituminous material will be avoided.

In the event Type 1 mixture is furnished, the plant shall contain a drier suitably designed to heat and dry the aggregate and to agitate it continuously during heating. The bituminous material shall be heated, preferably by steam coils, and in any case, the equipment shall be of such design that steam will not be introduced directly into the bitu-

minous materials. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

In the event Type 2 mixture is furnished, it is not necessary that the plant be equipped with a drier or heater to dry the aggregate.

4.04 Mixing:

The provisions contained in this article apply to Type 2 mixtures only.

To obtain good mixing results, insuring a thorough coating of the aggregate, it is recommended that the following routine of adding the materials entering into the mix be carried out. The mixer shall be operating while all items are being added. First, dump the coarse or larger of the aggregates in the mixer (if the coarse aggregate is dry, add a small amount of water only sufficient to coat), then add the emulsion, or this operation of introducing the aggregate and emulsion may be reversed, dependent on the type of mixer; followed by the hydrated lime after the aggregate has been thoroughly coated with emulsion; then dump the fine aggregate (sand). After completely coating all aggregate, add Portland cement; then continue mixing until the Portland cement is thoroughly dispersed throughout the whole mass; then dump immediately. The emulsified asphalt is not to be heated. In some instances, particularly dry aggregate may have to be wetted with water to insure a uniform covering with the bituminous material.

The plant must so operate that the aggregate will be completely coated with no "balling" of the fines or separation of coarse and fine aggregate.

4.05 Equipment:

All equipment necessary for the proper construction of this work shall be in satisfactory working condition and shall have been approved by the engineer before construction begins. The equipment shall be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of the following units:

1. Broom dragging equipment, capable of covering ⅓ to ½ the width of the treatment.
2. Power distributor equipment meeting the requirements set forth under "Equipment" in Article 2.03, Part 3, Division II.

3. Power rollers, weighing not less than 5 nor more than 7 tons.
4. Power revolving broom, or a power blower.

MATERIALS

4.06 Aggregate:

The mineral aggregate shall consist of any one of the following combinations: crushed stone and sand, crushed gravel and sand, crushed slag and sand or crushed stone alone. The materials shall meet the requirements as hereinafter set forth and shall be combined so as to meet the following mechanical analysis.

Sieves	Per Cent Passing			
	Binder Course		Wearing Course	
	Min.	Max.	Min.	Max.
1¼"	100			
¾"	80	100		
½"	70	95	100	
¼"	50	75	80	95
No. 10	35	60	40	65
No. 40	10	30	15	30
No. 80	2	10	3	15
No. 200	0	7	0	10

Crushed gravel shall consist of clean, hard, tough, durable fragments and shall be screened and crushed to sizes as necessary to meet the grading requirements. At least 80 per cent of gravel retained on a 10-mesh sieve shall have more than one crushed face. Gravel shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter. Crushed stone shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test.

Crushed slag shall be air-cooled, blast furnace slag, and shall consist of angular fragments reasonably free from flat or elongated pieces, dirt or other objectionable matter.

Crushed slag shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. It shall weigh not less than 70 pounds per cubic foot—dry rodded.

Sand shall consist of clean, hard, durable grains graded from coarse to fine, free from clay lumps, vegetable matter or any deleterious substance. The fraction passing the 40-mesh sieve shall have a plastic index not exceeding 2 when tested by the Method of Dry Preparation of Disturbed Soil Samples for Test, A.A.S.H.O. Designation: T 87.

The moisture content of the aggregate furnished for Type 1 mix, at the time of mixing, shall not exceed one per cent by weight.

Portland Cement: Portland cement furnished for Type 2 mix shall meet the requirements of Article 5.03, Part 4, Division II.

Hydrated Lime: Hydrated lime furnished for Type 2 mix shall be composed of not less than 95 per cent calcium and magnesium oxides.

4.07 Cutback Asphalt for Tack Coat:

The tack coat shall be Grade RC-1 Cutback Asphalt conforming to the requirements for same contained in Article 2.07, Part 3, Division II. Testing of cutback asphalt for tack coat shall be in accordance with said article.

4.08 Cutback Asphalt for Bituminous Mixture:

Cutback asphalt furnished for Type 1 mix shall be Grade RC-2 Cutback Asphalt conforming to the requirements for same contained in Article 2.07, Part 3, Division II. Testing of cutback asphalt for bituminous mixture shall be in accordance with said article.

4.09 Emulsified Asphalt for Bituminous Mixture:

Emulsified asphalt furnished for Type 2 mix shall be Grade EA-4 Emulsified Asphalt conforming to the requirements for same contained in Article 3.06, Part 2, Division II. Testing of emulsified asphalt for bituminous mixture shall be in accordance with said article, with the following addition: Residue from distillation shall be screened through a No. 50 sieve while hot and kneaded until uniform and homogeneous before testing for ductility and penetration.

CONSTRUCTION METHODS

4.10 Preparation of Road Surface:

The road surface shall be prepared in accordance with specifications contained in Article 3.15, Part 3, Division II.

4.11 Weather Limitations:

Bituminous materials shall not be applied on a wet base nor when the temperature of the air is less than 50°F in the shade.

4.12 Application of Tack Coat:

The tack cost shall be applied in accordance with Article 2.14, Part 3, Division II. The tack coat shall not precede the application of the bituminous mixture by more than 1,500 feet.

4.13 Preparation of Bituminous Mixture:

The bituminous material and aggregate shall be prepared by machine mixing on the job or at some central mixing point and shipped ready for use. Mixtures that do not remain workable a sufficient period of time to permit proper spreading and rolling will not be accepted. The aggregate must be completely coated with no "balling" of the fines or separation of coarse and fine aggregate.

4.14 Forms:

The use of forms will not be required except where necessary to support the edges of the pavement during rolling. If the pavement withstands rolling without undue movement, binder twine or small rope may be used to align the edges.

4.15 Transporting and Laying:

After the tack coat has been applied, the bituminous mixture shall be hauled to the work in tight vehicles previously cleaned of all foreign materials. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coating of cutback asphalt as required for the tack coating of the base.

In the event Type 1 mixture is furnished, the mixture shall be spread into place in one or more courses as indicated on the plans and in such amounts that after com-

paction by rolling as hereinafter provided, it shall conform to the typical cross section shown on the plans. After the material has been spread it shall be completely aerated by disking, blading or hand raking or by the use of any combination of equipment that will satisfactorily reduce the volatile and moisture content of the material to not more than one per cent. When the material is laid in more than one course, each course shall be allowed to cure thoroughly before placing the succeeding course.

In the event Type 2 mixture is furnished, the mixture shall be spread only in such amounts as will permit complete aeration by disking, blading or hand raking or by the use of any combination of equipment that will satisfactorily reduce the moisture content of the mixture. Complete aeration is interpreted to mean a reduction of moisture to less than 1% by weight of the dry material. The total quantity of mixture placed and spread shall be such that, after compaction by rolling as hereinafter provided, the course shall conform to the typical section shown on the plans. Where the plans provide for a binder course and a wearing course, the mixture in the binder course shall be thoroughly aerated and compacted after which the mixture shall be allowed to harden completely before the application of the wearing course.

4.16 Flush Structures:

Adjacent to flush curbs, gutters or other structures, the bituminous mixture shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb or flush structures.

4.17 Rolling:

When Type 1 mixtures are furnished, the entire surface shall be rolled with a power roller immediately after the mixture has been spread and the volatile and moisture content reduced to the required percentage as hereinbefore provided.

When Type 2 mixtures are furnished, after the mixture has been spread, aerated and bladed evenly, the entire surface shall be rolled with a power roller.

Rolling, regardless of the type mixture used, 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. On superelevated curves, rolling shall begin at the low side and progress toward the high side. Rolling shall be continued until all roller marks are eliminated and until at least 92 per cent of maximum theoretical density has been obtained, and at a rate of not more than 50 tons per hour for each roller used. If any displacement occurs, it shall be corrected at once by the use of rakes and the addition of fresh mixture where required. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the roller, the wheels shall be thoroughly wetted with water or coated with oil, care being taken to avoid excessive use of water or oil.

In addition to the above, the contractor shall comply with the following requirements when Type 2 mixture is furnished:

After complete aeration, the surface shall be rolled again in the manner specified above. Ordinarily 24 hours lapse of time will be required between the spread of the material and first rolling and between the first and second rolling. This may be increased under unfavorable conditions as directed by the engineer.

Should the surface be rained upon before rolling is completed, the rolling shall be stopped until the surface is dry. Should the bitumen "strip" from the aggregate, the mixture shall be removed and replaced with new material.

4.18 Hand Tamping:

Along curbs, headers and similar structures, and at all places not accessible to the roller or in such places as will not allow thorough compaction by the roller, the bituminous mixture shall be compacted thoroughly by hand tamping. The tamp may be oiled to prevent adhesion of the mixture.

4.19 Finishing:

The finished surface shall be uniform and shall conform to the lines, grades and typical cross sections shown on the plans. When tested with a 16-foot straightedge placed parallel to the center line of the roadway, the surface shall not vary in excess of $\frac{1}{16}$ of an inch per foot from the nearest point of contact and the minimum ordinate

measured from the face of the straightedge shall not exceed ¼ of an inch at any point. Any point on the surface not meeting these requirements shall be immediately corrected.

4.20 Opening to Traffic:

Except in an emergency, or where shown on the plans or in the special provisions, no portion of the finished wearing course, upon completion of rolling, shall be opened to traffic before the expiration of the time indicated below for the different type mixtures.

Type 1 Mixture	12 hours
Type 2 Mixture	24 hours

MEASUREMENT AND PAYMENT

4.21 Method of Measurement:

Bituminous mixture for cold application (binder course and wearing course) will be measured by the ton of 2,000 pounds, complete in place. In the event the mixture is shipped to the job in railroad cars and railroad scale weights are available, railroad track scale bill of lading weights shall be used. However, in the absence of railroad weights, the contractor shall furnish and use platform scales. The scales shall be satisfactory to the engineer and shall be sealed at the contractor's expense as often as the engineer may deem it necessary to insure their accuracy.

Asphalt for tack coat shall be measured by the gallon of 231 cubic inches, complete in place. The gallonage of asphalt material to be paid for shall be the number of gallons of asphalt material used as ordered in the accepted tack coat. Gallonage shall be determined by measuring the material at a temperature of 60°F, or by converting the gallonage measured at other temperature to gallonage at 60°F in accordance with the "Temperature-Volume Correction Tables For Asphaltic Materials" as set forth in Article 2.09, Part 3, Division II.

4.22 Basis of Payment:

The quantity of material placed and accepted, measured as provided above, shall be paid for at the contract price per unit for each of the various materials incorporated

in the completed and accepted work, which prices and payments shall constitute full compensation for furnishing all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item and for all royalties and payments whatsoever for patents covering processes or equipment used in constructing the item.

Payment will be made under:

Item 3-4-1, Bituminous Mixture for Cold Application (Binder Course), per ton.
Item 3-4-2, Bituminous Mixture for Cold Application (Wearing Course), per ton.
Item 3-4-3, Bituminous Tack Coat, per gallon.

SECTION 5

PORTLAND CEMENT CONCRETE PAVEMENT

5.01 Description:

This item shall consist of a pavement of Portland cement concrete, with or without reinforcement as shown on the plans, constructed on the prepared subgrade or completed and accepted base course in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross sections shown on the plans.

5.02 Proportions and Consistency of Concrete:

The contractor will be permitted to furnish any of the following types of concrete pavement, however, the same type pavement shall be used throughout the project.

Type B Concrete Pavement shall be composed of one part of Portland cement and 5 parts of total fine and grade B coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, 2 parts fine aggregate, and 3 parts of coarse aggregate, by volume.

Type C Concrete Pavement shall be composed of one part of Portland cement and $5\frac{3}{10}$ parts of total fine and grade B crushed slag coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, $2\frac{15}{100}$ parts fine aggregate and $3\frac{15}{100}$ parts of crushed slag coarse aggregate, by volume.

Type D Concrete Pavement shall be composed of one part of Portland cement and 5½ parts of total fine and grade D coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, 2 parts fine aggregate and 3½ parts of coarse aggregate, by volume.

Type E Concrete Pavement shall be composed of one part Portland cement and 6⅘ parts of total fine and small size and large size grade E coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, 2 parts fine aggregate, and 4⅘ parts of coarse aggregate, by volume.

The contractor's attention is directed to the fact that in Type E pavement, the 2 coarse aggregates will reduce in volume approximately 8 per cent when mixed.

The contractor will be permitted to use air-entrainment in concrete pavements with the written approval of the engineer. The method of obtaining air-entrainment shall conform to the requirements for same contained in Article 5.20, Part 4, Division II. The additional cost involved (if any) shall be assumed by the contractor. Its use, when permitted, shall not relieve the contractor from complying with all other requirements of these specifications.

Should the contractor desire to use High Early Strength Portland cement in any part of the work, other than as specifically provided for by the plans or in the special provisions, and if considered desirable by the engineer, the contractor may be permitted to use a High Early Strength Portland cement with the written consent of the engineer. The additional cost involved (if any) shall be assumed by the contractor. In the event the engineer orders the contractor to use High Early Strength Portland cement in any part of the work, other than as specifically provided for by the plans or in the special provisions, the contractor shall furnish and use such cement instead of Standard Portland cement, and the Department will reimburse the contractor for the difference between the delivered cost of the Standard Portland cement otherwise being furnished for use on the project. The contractor will be required to furnish freight bills and invoices to substantiate statements showing difference in cost.

After the job materials provided by the contractor have been accepted for use on the project, the engineer will set the job mix in accordance with the above requirements as

to total weight of aggregate, designating such relative amounts of fine to coarse aggregate, and such water cement ratio as will produce concrete of the consistency desired within the range of slump as hereinafter limited; during the progress of the work, the ratio of the amount of fine aggregate to the amount of coarse aggregate shall be altered as required by the engineer but the weight of total dry aggregate per bag of cement shall not be altered unless tests made under the authority of the engineer indicate that the specific gravity of either or both of the aggregates has changed. There will be no adjustment of cost of cement. Substitute mixes will not be accepted.

The unit weight of the aggregates in a dry and rodded condition shall be determined by the laboratory in accordance with the Method of Test for Unit Weight of Aggregate, A.S.T.M. Designation: C 29. The unit weight of aggregate, of a given specific gravity, is controlled by the voids and may affect the yield of concrete materially and the contractor's attention is directed to the type and grading requirements of the coarse aggregate hereinbefore specified for the several types of mixes.

The batch weights of aggregates, as given the contractor, will be corrected weights, adjusted by the engineer to compensate for moisture content, and shall be used by the contractor as job condition weights. The amount of water will be adjusted by the engineer to compensate for moisture content of the aggregates and for absorption of water by the aggregate during mixing. The contractor shall at once alter his batch whenever directed to conform to an adjusted or altered job mix.

The minimum cement content in barrels per cubic yard of concrete for the various types of mixes shall not be less than indicated in the following table. The maximum water content, including free water in the aggregate, in gallons per bag of cement shall not be greater than the following:

Type of Pavement	Maximum Gallons per Bag	Minimum Barrels per Cu. Yd.
B	5.50	1.45
C	5.75	1.50
D	5.50	1.35
E	6.00	1.25

The cement content indicated above is in each case the minimum permitted, but is not guaranteed by the Department. The cement content obtaining for any type mix is dependent upon the gradation of the aggregates and the cement content indicated above is based upon the most ideal combination and gradation of both fine and coarse aggregate for the respective type of pavement shown.

The consistency of the concrete shall be such that the slump of the concrete shall be not less than 1½ inches nor more than 3 inches when tested in accordance with the Method of Test for Slump of Portland-Cement Concrete, A.S.T.M. Designation: C 143.

If provided on the plans or in the special provisions, in addition to proportioning for the various types of concrete as provided above, the contractor will be permitted to base the proportions of cement, aggregates and water by the following method:

Proportions Based on Strength: Under this method, the proportions shall be based upon strength. Prior to bidding, the contractor should satisfy himself that the aggregates selected for use are acceptable as regards basic requirements for quality as provided elsewhere in these specifications under "Materials," and in addition should predetermine, for each available combination of aggregates, the proportions that will be required to produce concrete having the specified minimum flexural strength.

Subsequent to the receipt of bids and the determination of the successful bidder, the Department's laboratory will determine the proportions, based upon samples of the aggregates the contractor proposes for use on the project, and unless otherwise specified, the proportions shall be such that will produce concrete of satisfactory plasticity and workability which will attain at the age of 7 days a modulus of rupture of not less than 500 pounds per square inch.

In no case shall the cement content be less than 5 sacks per cubic yard, nor shall the net water cement ratio be more than 6½ gallons per sack of cement. The quantity of mixing water shall be adjusted to give a slump of not less than 1½ nor more than 3 inches. Laboratory test specimens shall be made and cured in accordance with the Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory, A.A.S.H.O. Designation: T 126. Tests for flexural strength shall be made in accordance

with the Method of Test for Flexural Strength of Concrete, A.A.S.H.O. Designation: T 97.

In order to determine that the concrete will meet the above requirements before the work is begun, the contractor shall have the mixer on hand at least 10 days prior to beginning concreting operations and shall run such trial batches as the engineer deems necessary so that sufficient test specimens may be made, cured and tested.

After the aggregates provided by the contractor have been accepted for use on the project, the engineer will designate the cement content in sacks per cubic yard, the maximum allowable net water cement ratio in gallons per sack and the consistency of the mix. The cement content will be that which the laboratory tests have determined is required for use with that particular combination of aggregates. The exact proportions will be based upon trial mixes with the materials to be used in the work and will be so adjusted as to use the minimum quantity of fine aggregate necessary to produce concrete of the required plasticity and workability. The proportions will be stated in terms of aggregates in a saturated surface-dry condition and the batch weights will have to be adjusted periodically to take into account the actual moisture content of the aggregates at the time of use. The designated proportions will govern during the progress of the work, except as hereinafter provided.

If the cement content of the concrete, determined by means of the standard yield test (Method of Test for Weight Per Cubic Foot, Yield, and Air Content [Gravimetric] of Concrete, A.A.S.H.O. Designation: T 121), varies by more than 2 per cent from the designated value, the proportions will be adjusted by the engineer so as to maintain the designated cement content.

If it is found impossible to obtain concrete of the desired plasticity and workability with the proportions originally designated, the engineer will make such changes in aggregate weights as he may deem necessary, provided that in no case shall the cement content be changed except as provided below.

If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable net water cement ratio specified herein, the cement content shall be increased as directed by the engineer so that the maximum allowable water cement ratio will not

be exceeded. No additional compensation will be made for extra cement which may be necessary by reason of such adjustment.

No change in the sources or character of the materials shall be made without due notice to the engineer, and no new materials shall be used until the engineer has accepted such materials and has designated new proportions for the mix based on tests and trial mixes conducted by the engineer.

5.03 Engineer's Field Laboratory:

The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory shall not be less than 10 feet wide, 12 feet long and 7 feet high, floored and provided with a work bench with necessary drawers and shall have not less than 2 windows. The laboratory shall be for the exclusive use of the engineer and for testing purposes, but shall remain the property of the contractor and be removed by him upon completion of the project.

5.04 Equipment:

All equipment necessary for the proper preparation of the subgrade, mixing concrete, the laying and finishing of the pavement shall be on the project, in satisfactory working condition, and shall have been inspected and approved by the engineer before concreting operations will be permitted to begin. All equipment shall meet the specific requirements hereinafter set forth. The contractor shall maintain all equipment in satisfactory working condition throughout the construction of the project.

MATERIALS

5.05 Portland Cement:

Portland cement shall meet the requirements of Article 5.03, Part 4, Division II.

Different brands of cement, or the same brand of cement from different mills, shall not be mixed during use nor shall they be used alternately unless written approval has been granted by the engineer.

5.06 High Early Strength Portland Cement:

High Early Strength Portland cement shall meet the requirements of Article 5.04, Part 4, Division II.

5.07 Water:

Water for use with cement in mortar or concrete shall meet the requirements of Article 5.05, Part 4, Division II.

5.08 Fine Aggregate:

Fine aggregate shall meet the requirements of Article 5.06, Part 4, Division II.

5.09 Coarse Aggregate:

Coarse aggregate shall meet the requirements of Article 5.07, Part 4, Division II.

5.10 Bar Reinforcement:

Bar reinforcement shall meet the requirements of Section 6, Part 4, Division II. Specific reference is made to Article 6.04.

5.11 Fabric Reinforcement:

Wire for fabric reinforcement shall meet the requirements of Section 6, Part 4, Division II. Specific reference is made to Article 6.03.

5.12 Tie Bars:

Tie bars shall be deformed reinforcing steel of the size and length shown on the plans and shall meet the requirements of Article 6.02, Part 4, Division II. When split slab construction is employed, or when bending of the bar is required, hard grade steel will not be permitted.

5.13 Load Transmission Devices:

Load transmission devices shall be either dowel bars or cantilever type devices, all as shown on the plans.

Dowel bars shall conform to the details on the plans and shall meet the requirements of Article 6.02, Part 4, Division II.

Cantilever type devices shall be fabricated of cast malleable iron conforming to the details shown on the plans. The castings forming each of the 2 sections shall be manufactured of malleable iron meeting the requirements of the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47, Grade 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 shall assemble 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.

5.14 Wood Filler:

Wood filler shall be furnished to dimensions specified on the plans and shall meet the requirements of the Specifications for Redwood Board Expansion Joint Filler for Concrete, A.A.S.H.O. Designation: M 90, with the following exceptions: Other species of wood, meeting the specifications, may be used in lieu of Redwood. In testing for compression, a sample, ¾ of an inch thick and not less than 6 inches square, shall be compressed to ½ of its original thickness by a force of not more than 2,500 pounds per square inch.

Wood filler furnished for expansion joints and construction joints shall conform to the above requirements.

Wood filler furnished for dummy joints shall conform to the above requirements except the test for compression will not be required.

5.15 Preformed Fillers:

(a) Preformed Asphaltic Strips: Preformed asphaltic strips shall be furnished to dimensions shown on the plans and shall meet the requirements of the Specifications for Preformed Expansion Joint Filler for Concrete, Bituminous Type, A.S.T.M. Designation: D 994.

(b) Preformed Strips (Resilient): Preformed strips (resilient) shall be furnished to dimensions shown on the

plans and shall meet the requirements of the Specifications for Preformed Expansion Joint Fillers for Concrete, Non-extruding and Resilient Types, A.S.T.M. Designation: D 544, Type III, Standard-Medium Resilient.

5.16 Asphalt Mineral Filler:

Asphalt mineral filler shall be homogeneous and shall be composed of bitumen and mineral filler. The bitumen shall be free from impurities. The asphalt mineral filler shall conform to the following requirements:

	Min.	Max.
1. Melting Point Ring and Ball, °F	125	145
2. Penetration at 32°F, 200g, 1 min	22	.....
3. Penetration at 77°F, 100g, 5 sec	50	65
4. Ductility at 100°F, cm	20	.....
5. Bitumen Soluble in Carbon Disulphide, %	40	50
6. Mineral Filler, %	50	60
7. Water (By Distillation), %	.....	2

5.17 Black Traffic Stripes:

Black synthetic iron oxide for traffic stripes shall conform to the requirements of the Specifications for Black Synthetic Iron Oxide, A.S.T.M. Designation: D 769.

5.18 Cotton Mats:

Cotton mats shall meet the requirements of the Specifications for Cotton Mats for Curing Concrete, A.A.S.H.O. Designation: M 73.

5.19 Burlap:

Burlap shall weigh not less than 9 ounces per square yard. Worn burlap, burlap with holes, and burlap reclaimed from other uses than that of curing concrete will not be permitted. New burlap having "misprint brands" or stenciling will be permitted. If burlap is furnished in strips, they shall be in no case less than 3 feet in width and for transverse laying, the strips after full shrinkage shall be not less than 2 feet longer than the width of the pavement slab under construction.

5.20 Waterproof Paper:

Waterproof paper shall meet the requirements of the Specifications for Waterproof Paper for Curing Concrete, A.A.S.H.O. Designation: M 139, except that paper shall consist of one sheet of bleached kraft and one sheet of natural kraft.

The paper as prepared for use shall have such dimensions that a single unit will extend from one bottom corner of the slab to the opposite bottom corner of a slab of normal width, with allowance for shrinkage of the paper, and shall cover a length of slab of not less than 20 feet. Paper not manufactured in sufficient sizes to provide the dimensions specified above shall be securely cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period and are airtight.

5.21 Curing Compounds:

(a) Impervious Membrane Curing Compound: Curing compound shall be of a consistency suitable for spraying, shall be relatively non-toxic, and shall satisfactorily adhere to a horizontal surface of damp concrete when applied immediately after the disappearance of surface water. The resultant film shall be continuous, uniform, free from pinholes, moisture impermeable and shall not react with the components of concrete. The compound shall be supplied with a fugitive dye, which shall show no indication of its use in 15 days.

Testing for the efficiency of membrane curing compound furnished for use on this project shall conform to the Method of Test for Water Retention Efficiency of Liquid Membrane-Forming Compounds and Impermeable Sheet Materials for Curing Concrete, A.S.T.M. Designation: C 156, however, when applied to test specimens, at the rate of coverage recommended by the manufacturer for one application, the specimens shall not lose more than the maximum amount of moisture as follows:

At 24 hours	2.5%*
At 72 hours	5.5%
At 7 days	7.0%

*Based on moisture remaining in specimen at time of coating. The specimen shall remain in the mold throughout the test.

The compound shall be of such viscosity that it may be readily applied, by standard power-spraying equipment, at temperatures above 40°F.

The compound shall be dry to touch, on a damp horizontal concrete surface, in not more than 2 hours at a temperature of 75°F when applied at the rate of coverage recommended by the manufacturer.

(b) Membrane Curing Compound Pigmented: Curing compound shall comply with all requirements for "Impervious Membrane Curing Compound" hereinbefore contained and in addition shall meet the following specific requirements:

The compound, when applied to a new concrete surface at the specified coverage, shall provide a uniformly white appearance and shall effectively obscure the original color of concrete. After the compound has dried, it shall have an apparent daylight reflectance of not less than 60 as determined by Method 612 of Federal Specifications TT-P-141a. The compound shall have a hiding power of not less than 80 square feet per gallon, when tested as follows:

The 1-square foot test area of a black and white checker board hiding power chart (type used in Federal Specifications TT-P-141a, Method 411.1) shall be cut into 4 equal rectangles, dried at 221° to 230°F for 1 hour, cooled, and weighed. The sealing compound shall be sprayed on 2 of the rectangles in an amount that barely permits identifying a contrast between the black and white areas. On the other 2 rectangles the compound shall be applied in an amount slightly more than necessary to completely eliminate the contrast between the black and white areas. The coated rectangles shall then be dried at 221° to 230°F for 3 hours, cooled, and weighed. The hiding power shall be computed from the following formula:

$$\text{Hiding power in sq. ft./gallon} = \frac{Wg \times S}{Wd \times 100}$$

Where, Wg = Weight per gallon of compound in grams
S = Solids content of compound (Paragraphs 7 and 8, ASTM D 154-43)
Wd = Total weight of dried coatings on all 4 rectangles.

CONSTRUCTION METHODS

5.22 Conditioning of Subgrade:

After the subgrade has been properly prepared and shaped in accordance with Article 4.12, Part 1, Division II, the forms shall be set as hereinafter prescribed. The subgrade under the forms shall be hard and true to grade so that the form when set upon it will be firmly in contact for its whole length and actually at the desired grade. Any subgrade which at the form line is found below established grade shall be filled to grade in lifts of ½ inch or less for a distance of 18 inches on each side of the base of the form, and thoroughly rerolled or tamped. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

When side forms have been securely set to grade, the subgrade shall be tested as to cross section elevation by means of a templet approved by the engineer. The templet shall be so constructed and operated to correctly indicate locations where the subgrade does not conform to specified elevation and section. High areas shall be trimmed to proper elevation. Low areas shall be brought to proper elevation by filling with approved material which shall be tamped or rolled to a compacted condition similar to that of surrounding subgrade. Pavement shall not be placed on a rutted subgrade. The subgrade shall be kept in a condition so that it will drain readily.

A subgrade planer shall be used immediately before concrete is placed as a final check of subgrade elevations and cross section. This planer, or machine, shall have a cutting edge, or edges, set to conform accurately to the specified cross section elevations. The machine shall be mounted on visible rollers, or wheels, operating on the pavement side forms, and shall be of sufficient weight to plane off any high spots encountered and shall have such strength and rigidity as will prevent vertical deflection of not more than ⅛ inch when supported at its center instead of at the rollers or wheels. If the mixer is operated between the forms, the planer may be attached at the discharge end of the mixer. If the mixer is outside the forms, or in cases where central- or transit-mixed concrete is used, an independently powered planer will be required. Material planed off the subgrade shall be removed before concrete is placed. Low areas in the subgrade may be filled with suit-

able material and compacted to similar condition of surrounding subgrade or filled with concrete integral with the pavement. No additional compensation will be allowed for the extra quantity of concrete involved. The finished subgrade shall be maintained in a smooth and compacted condition until the pavement is placed.

The subgrade shall be uniformly moist but not muddy when the concrete is placed. If required by the engineer, it shall be saturated with water the previous night or not less than 6 hours previous to the placing of the concrete. If it subsequently becomes too dry, the subgrade shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

At all times during operations, at least 500 feet of subgrade shall have been prepared ahead of the mixer. Concrete shall not be placed on a frozen subgrade. No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment.

5.23 Forms:

Side forms shall be fabricated from steel into an approved cross section which will insure rigidity under the impact, thrust and weight of the heaviest equipment designed to be placed upon them.

The depth of the forms shall be equal to the adjacent edge thickness of the cement concrete base of pavement. Forms of depth greater than the edge thickness specified, will be permitted provided the outer portion of the slab is thickened to equal the depth of the form by tapering at the rate of one inch of the thickness per foot of width. All additional concrete required for this purpose shall be placed at the expense of the contractor.

The width of the base of the steel forms in direct contact with the subgrade shall be equal at least to the height of the forms but in no case shall the width of the base be less than 8 inches. The flange braces shall extend outward on the base not less than ⅔ the height of the form. The thickness of the steel forms shall be not less than 7/32 inch.

The forms shall be produced in units of a minimum length of 10 feet. Three steel stakes of 1-inch diameter and at least 16 inches long and of sufficient additional length to insure proper bearing support, shall be provided for each

10-foot length of form and each of the 3 stake pockets shall be equipped with steel wedges for securely keying the forms to the stakes.

Forms shall not deflect more than ¼ inch when tested as a simple beam with a span of 9 feet 6 inches and a load equal to that exerted by construction equipment placed upon them.

The forms shall be straight and free from distortion. They shall show no vertical variation greater than ⅛ inch in a 10-foot length from the true plane of the surface on the top of the form when tested with a 10-foot straightedge. They shall show no lateral variation greater than ¼ inch from a true plane surface of the vertical face of the form when tested with a 10-foot straightedge.

Connections between adjacent sections shall form a lock joint free from vertical movement in excess of ⅛ inch and from horizontal movement in excess of ¼ inch under the impact, thrust and weight of the heaviest machine carried on 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 by the engineer. Built-up forms shall not be used.

5.24 Setting Side Forms:

Forms shall be set so that they rest firmly throughout their length upon the compacted subgrade at the desired grade and any deviations therefrom shall be corrected as provided in Article 5.22. After the forms have been set to correct grade, the subgrade shall be thoroughly tamped by means of mechanical tampers at both the inside and outside edges of the base of the forms. In exceptional cases, the engineer may require suitable stakes driven to the grade of the bottom of the forms to afford additional firmness. The engineer may require the contractor to operate the finishing machine and subgrader over the forms prior to the starting of construction in order to determine whether the forms will remain true to line and grade during the construction of any portion of the pavement. Any weakness or defects which may develop in the forms under this operation will be cause for their immediate rejection. The length and number of pins required for each section of forms shall be such as may be required to maintain the form at the correct line and grade at all times, but in no case shall

less than 3 pins for each 10-foot section be used and a pin shall be placed at each side of every joint. Conformity of the alignment and grade elevation of forms with the alignment and grade elevation shown on the plans, or designated by the engineer, shall be checked and necessary corrections made by the contractor immediately prior to placing the concrete. Where any form has been disturbed, or any subgrade becomes unsuitable, the form shall be reset and rechecked. Forms shall be set for at least 500 feet in advance of the point where concrete is being placed.

Forms shall be cleaned and oiled each time they are used.

5.25 Devices For and Methods of Measuring Materials:

All cement and aggregate for concrete pavements shall be measured by weight. Cement packed in bags by the manufacturer shall be considered to weigh 94 pounds. Batches involving fractional bags will not be permitted. If bulk cement is used, separate scales and hoppers shall be used for the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. The weights of coarse and fine aggregates to be used shall be calculated from the proportions specified by the engineer for the job mix. Water shall be measured by volume or by weight.

5.26 Weighing and Batching Equipment:

Bins: The batching plant shall include batcher bins, of either stationary or portable type, with adequate separate compartments for cement and for each required "separate size" of fine and coarse aggregate, each compartment designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided in each case so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly in small quantities and shut off with precision. Means of removing an overload of any one of the several materials shall be provided. Hoppers shall be constructed so as to eliminate accumulation of tare materials and to fully discharge without jarring the scales. Adequate partitions shall separate the cement and aggregates both in the weighing bins and hoppers. Partitions between compartments, both in bins and in hoppers, shall be ample to

prevent spilling under any working condition. All batching plant structures shall be maintained properly leveled within the accuracy required by the design of the weighing mechanism.

Scales: The scales for weighing aggregates and cement may be of either the horizontal beam or the springless dial type, designed as an integral unit of the batching plant and of rugged construction to withstand hard usage due to working conditions. When beam type scales are used, provisions, such as a "telltale" dial, shall be made for indicating to the operator that the required load to the weighing hopper is being approached, which device shall indicate at least the last 200 pounds of load. There shall be a device on weighing beams which shall indicate the critical position clearly. Poises shall be designed for locking in any position and to prevent unauthorized removal. The weigh beam and "telltale" device shall be in full view of the operator in charge of the hopper, and he shall have convenient access to all controls. Multiple weigh beams on scales to be used for weighing more than one kind of material shall have as many beams as the number of different kinds of material to be weighed on the scale. The individual beams shall have such capacities as will allow the required weight of each kind of material to be set off on a single beam or on a single beam and fractional beam. The cement and water (if weighed) shall be weighed on separate scales. The capacity of any scale shall not be greater than twice the weight of the amount required for the smallest batch size normally weighed.

Graduated dials shall be provided with suitable markers, inside the glass cover and in front of the dial, which may be set to indicate the position of the dial indicator for predetermined loads in the weighing hopper.

The hopper and scales shall be suitably enclosed for protection against the influence of wind.

Ten 50-pound standard test weights shall be provided at each batch plant for testing weighing equipment.

The scales shall be maintained within a tolerance of ½ per cent of the net load in the hopper. The minimum graduation on the beam or dial shall not be greater than 0.2 per cent of the rated capacity of the scales. All cement handling, weighing and batching apparatus shall be protected from the weather.

Clearance between scale parts, hoppers and bin structure shall be such as to avoid displacement of or friction between parts due to accumulations, vibration or other causes. Pivot mountings shall be designed so none of the parts will jar loose and so as to assure unchanging spacing of knife edges under all circumstances. Scales shall be so designed that all exposed fulcrums, clevises and similar working parts may readily be kept clean. The weighing mechanism of the scales shall be constructed of noncorrosive materials, excluding material softer than brass. Weigh beams shall have leveling lugs, and weighing parts of other types shall be provided with means for precision adjustment. Scales shall be sealed at the expense of the contractor when required by the engineer.

Accuracy of the water measuring equipment shall be within a range of error of not over ½ per cent and shall be so arranged that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions encountered. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting of same unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

5.27 Handling Materials:

In stock-piling aggregates, the location and preparation of the sites, the minimum size of pile, the method adopted to prevent "coning" or to provide segregation of the component sizes shall be subject to the approval of the engineer. In any case, stock piles shall be at least 6 feet in height and built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to "cone" down over the under layer. Aggregates from different sources and of different gradings shall not be stock-piled together. Each "separated size" of coarse aggregate, if Type E pavement is furnished, shall be stored separately. The contractor shall avoid as much as possible the mixing of material from the stock pile with material from the cars when filling the proportioning bins and shall not fill

the proportioning bins alternately from the stock pile and cars, except when directed to do so by the engineer for the purpose of changing the gradation of the materials. He shall fill the bins exclusively from the stock pile. Storing of aggregates in stock piles or otherwise upon the subgrade or shoulders will not be permitted.

The aggregates shall be handled from the stock pile or other sources to the batching plant in such a manner as to secure a typical grading of the material. Aggregates that have become mixed with earth or foreign material or coated with dust shall not be used. All aggregates, where handled by hydraulic methods or where washing is involved, shall be stock-piled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.

Aggregates 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. Where cement is batched in bulk, the contractor shall use a suitable method of handling the cement from the weighing hopper to transporting container or into the batch itself for transportation to mixer, with chute, boot or other approved device, to prevent loss of cement and arranged to provide positive assurance of the actual presence in each batch of the entire cement content specified.

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. Loose cement shall be transported to the mixer either in waterproof compartments carrying the full amount of cement required for the batch or between the fine and coarse aggregate. Batches where cement is placed in contact with the aggregate may be rejected unless mixed within 1½ hours of such contact.

Batches shall be delivered to the mixer separate and intact and each batch container shall be dumped cleanly into the mixer without loss of cement or mixing or spilling of material from one batch compartment into another.

5.28 Mixing Conditions:

Concrete shall be mixed only in the quantity required for immediate use. Concrete which does not meet the re-

quirements for consistency at the time of placing shall be rejected. Retempering concrete by adding water or by other means will not be permitted.

The use of admixtures for the purpose of increasing the workability of the mix or for accelerating the set, will be permitted only when specifically approved by the Chief Engineer in writing.

Materials containing frost shall not be used. Fine aggregate containing lumps of hardened materials shall not be used.

Salt or other chemical admixtures shall not be added to the concrete to prevent freezing.

The use of ready-mixed concrete will be permitted. When ready-mixed concrete is used, the concrete shall be mixed to such consistency that the hauling will cause no segregation of the constituent materials. The methods of storing and hauling materials and equipment used shall be subject to the approval of the engineer. Vehicles shall be equipped with suitable devices for slowly agitating the concrete during transit and for the delivering of the concrete in an unsegregated condition of uniform consistency. Any vehicle load showing non-uniform consistency upon arrival will be subject to rejection.

5.29 Batch Mixers for Use at Site of Work:

Mixers shall be of the boom and bucket type, full power controlled, and no mixer less than one cubic yard capacity shall be used except where it is impracticable to use machine methods of placing and finishing the concrete, a smaller mixer of the design approved by the engineer and having a capacity of not less than 2 bags will be permitted.

Mixers shall operate at the drum speed shown on the manufacturer's name plate which, unless otherwise approved, shall be not less than 14 nor more than 20 revolutions per minute.

The mixer shall be equipped with an approved batch meter and timing device which will automatically lock the discharge lever and release it only at the end of the mixing period; the device shall be equipped with a bell adjusted to ring each time the lock is released. If the timing device becomes broken or out of order, the contractor shall be permitted to operate the mixer while same is being repaired, provided he furnishes an approved timepiece equipped with

a minute hand and a second hand and each batch is mixed 1½ minutes while the timing device is out of order. If, in the opinion of the engineer, the repair of the timing device is unreasonably delayed, the failure of the timing device shall be cause for the discontinuance of the use of the mixer until the device is repaired or a new timer substituted.

The water measuring equipment shall meet the requirements set forth under "Weighing and Batching Equipment," Article 5.26.

Pickup and throw over blades in the drum of the mixer which are worn down ¾ of an inch or more in depth must be replaced by new blades.

Tandem or dual drum mixers will be permitted provided the mixer units are designed and built for synchronized operation and provided the material is mixed in the first drum for a period of not less than 30 seconds.

Mixers for ready-mixed concrete shall conform to the requirements for same contained in Article 5.31.

5.30 Mixing Concrete at Site of Work:

Concrete shall be mixed in a batch mixer of approved type and capacity for a period of not less than one minute after all materials except water are in the drums. If tandem or dual drum mixers are used, the mixing time required shall be exclusive of the time of transfer of materials between mixing drums or compartments.

The batch shall be so charged into the drums that some water shall enter in advance of cement and aggregate and shall continue to flow at a uniform rate for a period not exceeding 20 seconds. The rate of flow shall be so regulated that the water will enter the drum for approximately 5 seconds before the materials and continue to flow for approximately 10 seconds after the materials have been charged into the drum, and after the mixing time begins.

During the period of mixing, the drum shall operate at the speed for which it was designed. Any concrete mixed less than the minimum mixing time specified shall be rejected. If, in the opinion of the engineer, the concrete resulting from mixing the specified minimum time is not of a uniform texture, a sufficient number of additional revolutions of the drum at the same rate shall be given until a thorough mixing of each batch of concrete is secured.

No batch shall be run requiring fractional sacks of cement, unless bulk cement is furnished, and the volume of mixed concrete per batch shall not exceed the manufacturer's rated capacity by more than 10 per cent, except where the rated capacity of the mixer exceeds the volume of the mixed concrete for the nearest to capacity bag batch by a volume of concrete involving $\frac{3}{10}$ or more of a bag of cement, in which case the volume of concrete produced per batch may be that produced from a number of bags of cement which exceeds the nearest to rated capacity number by one bag. The entire contents shall be removed from the drum before the succeeding batch is introduced. The skip and the throat of the drum shall be kept free of accumulations.

Mixing of ready-mixed concrete shall conform to the requirements for same contained in Article 5.31.

5.31 Ready-Mixed Concrete:

(1) Ready-mixed concrete shall be transported in truck mixers, truck agitators, or in other approved vehicles, provided that the haul units and delivery time are such that segregation is avoided and concrete of specified consistency is delivered at the site.

(2) Definitions: (a) Ready-mixed concrete is central-mixed concrete or transit-mixed concrete transported and delivered in a plastic state ready for placement in the work. It shall be the type of concrete selected for use by the contractor prepared in accordance with the job mix proportions established by the engineer as provided in Article 5.02. All ingredients shall meet the quality and gradation requirements hereinbefore specified under "Materials."

(b) Central-mixed concrete is concrete which has been mixed in a central mixing plant approved by the engineer.

(c) Transit-mixed concrete is concrete mixed in a truck mixer while in transit to the destination.

(d) Shrink-mixed concrete is concrete which has been partially mixed in a central mixing plant, the mixing then being completed in a truck mixer while in transit to the destination.

(e) Agitating is the process of continuing the mixing of central-mixed concrete at the reduced speed specified, for the purpose of preventing segregation while in transit to the destination.

(3) Quality: Ready-mixed concrete shall be proportioned and batched as hereinbefore provided for the various types of concrete pavement, and shall meet all requirements as to quality, materials, strength, etc.

(4) Equipment: (a) The mixing equipment shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass and of discharging the mixture without segregation. Either the revolving drum type or the revolving blade type of mixer will be permitted. The mixer shall not permit leakage of any of the ingredients of the concrete.

(b) For central mixing, the size of the mixer drum shall be in accordance with the concrete mixer standards adopted by the Mixer Manufacturers Bureau of the Association of General Contractors of America. The mixer shall be equipped with a batch meter, a locking device capable of preventing the discharge of the concrete until the specified mixing time has elapsed, and a water measuring device meeting the requirements hereinafter contained.

(c) The truck mixer shall be equipped with a revolution counter, and with a locking device capable of preventing the discharge of the mixer prior to the completion of the required number of drum revolutions. If it is desired to add the mixing water while in transit, the truck mixer shall be equipped with a tank. Except when the exact amount of required mixing water is placed in the tank at the proportioning plant, the truck mixer shall be equipped with a water measuring device meeting the requirements hereinafter contained.

(d) The truck agitator shall be capable of transporting and discharging central-mixed concrete without segregation at the consistency specified and without leakage of any of the ingredients of the concrete. Unless otherwise specified by the engineer, the use of open-top agitators will not be permitted.

(e) Each truck mixer and each truck agitator shall have attached to it, in a prominent place, a metal plate on which is stamped its rated capacity in cubic yards of mixed concrete, as guaranteed by the manufacturer for the different uses to which the equipment is adapted.

(f) Other transportation equipment than that described in the foregoing paragraphs, if the use of same is permitted by the engineer, shall conform to such requirements as the engineer may designate.

(5) Central Mixing: The mixer shall be rotated as provided in Article 5.30, or, if so specified, at the rate recommended by the manufacturer. The mixing time shall be measured from the time that all cement and aggregates are in the mixer. The batch shall be so charged into the mixer that some water shall enter in advance of cement and aggregate and water shall continue to flow into the mixer for a period which shall not extend beyond the end of the first ¼ of the specified mixing time. When the central plant is used for the complete mixing of the concrete to be transported in an agitator truck, the mixing time for mixers having a capacity of one cubic yard or less shall be not less than one minute; for mixers of larger capacity, this minimum mixing time shall be increased at the rate of 15 seconds or more for each cubic yard, or fraction thereof, additional capacity.

(6) Transit Mixing: The size of the batch shall conform to requirements hereinafter contained under "Capacities." When the mixer is charged with fine and coarse aggregates simultaneously, not less than 50 nor more than 100 revolutions of the drum or blades at mixing speed shall be required after all the ingredients, including water, are in the drum. When fine and coarse aggregates are charged separately, not less than 60 revolutions shall be required. Additional mixing beyond 100 revolutions, if any, shall be done at agitating speed. Mixing shall start immediately after the cement and water, or the cement and wet aggregates, come in contact. Mixing and agitating speeds shall conform to the requirements hereinafter contained under "Mixing Speeds." The ingredients of the batch shall be completely discharged from the drum before the succeeding batch is placed therein. Drums and auxiliary parts of the equipment shall be kept free from accumulations of materials.

(7) Shrink Mixing: For shrink mixing, the mixing time at the central mixing plant may be reduced to a minimum of 30 seconds to intermingle the ingredients and the mixing may be completed in a truck mixer. All ingredients for the batch shall be in the central mixer and partially mixed before any of the mixture is discharged into the truck mixer. The partially mixed batch shall be transferred to the truck mixer without delay and without loss of any portion of the batch, and mixing in the truck mixer shall start immediately. The mixing time in the truck mixer shall not be less than 40 nor more than 100 revolutions of the

drum or blades at mixing speed. Units designed solely as agitators shall not be used in connection with shrink mixing. Except for the preceding requirements, shrink mixing shall conform to the requirements contained above for "Transit Mixing."

(8) Agitating: When central-mixed concrete is transported in a truck agitator or a truck mixer, the size of the batch and the agitating speed shall conform, respectively, to the requirements hereinafter contained under "Capacities" and "Mixing Speeds." The central-mixed batch shall be transferred to the agitating unit without delay and without loss of any portion of the batch. Agitating shall start immediately thereafter and shall continue without interruption until the batch is discharged from the agitator. The ingredients of the batch shall be completely discharged from the agitator before the succeeding batch is placed therein. Drums and auxiliary parts of the equipment shall be kept free from accumulations of materials.

(9) Mixing Water: Mixing water for both central mixing and transit mixing shall be measured by volume or by weight. The device for the measurement of the water shall be readily adjustable and, under all operating conditions, shall be accurate to ½ of one per cent of its maximum capacity. The quantity of water used shall be the amount determined by the job-mix proportions established by the engineer within the tolerance permitted for the measuring device.

For transit mixing the addition of water to the cement and aggregate shall be so timed that the maximum mixing time will not be exceeded. The mixing water may be added at the time of charging the mixer with cement and aggregates; or at a point located between the proportioning plant and the destination; or may be added from a tank on the truck mixer during transit. The full amount of mixing water shall be added in one operation. Unless otherwise authorized by the engineer, all rinse or wash water shall be completely discharged from the drum or container before the succeeding batch is placed therein.

(10) Mixing Speeds: The mixing speed for the revolving drum type of truck mixer shall not be less than 4 revolutions per minute of the drum, nor greater than a speed resulting in a peripheral velocity of the drum of 225 feet per minute. For the revolving blade type of mixer,

the mixing speed shall be not less than 6 nor more than 16 revolutions per minute of the mixing blades.

Agitating speed, for both the revolving drum and revolving blade types, shall be not less than 2 nor more than 6 revolutions per minute of the drum or of the mixing blades.

(11) Capacities: The volume of batch in the truck mixer, or the truck agitator, shall in no case be greater than the manufacturer's rated capacity for the particular use in question, as shown by the rating plate, nor shall it be greater than the following percentages of the gross volume of the drum or container:

For truck mixing	57.5%
For shrink mixing	70.0%
For agitating	80.0%

For the purpose of determining the gross volume of the container of the revolving blade type of truck mixer or agitator, the height of the container above the center shaft shall be considered no greater than the radius of the circular section of the container below the center shaft, and the over-all width shall be considered no greater than the diameter of the circular section.

(12) Time of Haul: Unless otherwise directed, concrete transported in truck mixers or truck agitators shall be delivered to the site of work and completely discharged from the hauling container within a period of 60 minutes after the cement comes in contact with the mixing water, or with the combined aggregates when the combined aggregates contain free moisture in excess of 2 per cent by weight.

(13) Production and Delivery: The production and delivery of ready-mixed concrete shall be such that placing and finishing shall be continuous insofar as the job operations require. The contractor shall be responsible for producing a concrete that will have the required consistency when delivered to the work, even though the requirements regarding time of haul contained in the above paragraph have been met. Concrete which is unsuitable for placement as delivered shall be rejected.

The use of admixtures for increasing the workability or for accelerating the set will be permitted only when specified in the special provisions, or when permitted in writing by the Chief Engineer.

The engineer may require such modification of procedure as will produce satisfactory results, and if it shall prove impracticable to complete the work before the concrete becomes too stiff to finish properly, he may order the discontinuance of the use of central-mixed or transit-mixed concrete and require the use of concrete mixed at the site of the work.

5.32 Placing Concrete:

Concrete shall be placed only on a subgrade prepared and maintained as hereinbefore prescribed and no concrete shall be placed until the subgrade has been approved by the engineer. The concrete shall be deposited on the subgrade in such manner as to require as little rehandling as possible. It shall be thoroughly spaded against and along the face of the forms. Necessary hand spreading shall be done with shovels, not with rakes. Workmen shall not be allowed to walk in the green concrete with boots covered with earth. The concrete shall be distributed to such depth and sufficiently above grade that, when consolidated and finished, the required slab thickness will be obtained and the surface will at all points be true to the grade specified for the finished surface.

In placing concrete adjacent to transverse expansion joints and other transverse joints, the concrete shall be spaded around the joint filler and around and under tie bars and load transmission devices in such manner as to avoid displacement of any part of transverse joints. Concrete shall not be dumped directly upon or against such joints and, any displacement of wood filler, tie bars and/or load transmission devices caused by placing concrete and subsequent operations shall be immediately corrected.

No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment and all structures, or other fixtures such as valve boxes, poles, etc., shall be separated from the concrete by expansion joints constructed as hereinafter specified in Article 5.34.

The pavement may be constructed to its full width in a single construction operation unless the plans or special

provisions require construction in longitudinal sections. Concrete in a longitudinal section shall not be placed until the adjacent slab has attained an age of 10 days, or has attained a modulus of rupture of 600 pounds as shown by a test of standard specimens cured under the same climatic and moisture conditions as the slab. The junction line shall not deviate from a true line by more than ½ inch at any point and shall be tooled to the radius shown on the plans.

Placing shall be continuous between transverse joints without the use of intermediate bulkheads.

All ends of pavement slabs not supported by dowel bars embedded in adjoining concrete slabs or directly supported by bearing on adjoining structures shall be thickened as required by the plans.

No more concrete shall be mixed and placed than can be properly compacted and finished, as hereinafter specified, during daylight hours, without the written consent of the engineer and then only when an adequate lighting system satisfactory to the engineer is provided.

5.33 Placing Reinforcing Steel:

When required by the plans, reinforcing steel of the type and size designated on the plans shall be placed in the slab. All reinforcing metal shall be clean, free from rust flakes, mill scale or other foreign material that will prevent proper bond with the concrete; and it shall be straight and free from distortion. All reinforcing steel shall be placed in approved storage; it shall not be distributed along the work site, except as needed to avoid delay to paving.

When the type of steel to be furnished consists of reinforcing bars, the bars shall be placed in the position shown on the plans and shall be securely fastened together at each intersection by means of approved spring clips, wire ties or other approved devices, so that they will not be displaced during handling. Electric welding will be permitted provided the bars after having been welded meet the requirements of the specifications. Bar mat assemblies shall be placed, secured and lapped at adjacent ends as shown on the plans or as directed by the engineer. When bars are spliced all adjacent ends shall be lapped at least 35 diameters. After placement of the bars, the concrete shall be so deposited and distributed for the full width of

the pour that when finished, the pavement shall have the required thickness and crown, however, the bar mat assemblies shall be so placed that there will be no displacement during concreting operations.

When steel fabric is required, it shall be handled with care and kept free from bends and warps. It shall be placed parallel to the finished surface and at the depth shown on the plans. At all places where continuity of reinforcement is required, adjacent sheets of fabric shall be properly lapped. Unless otherwise shown on the plans, where laps are made along the sides of the sheets, the transverse wires of the fabric shall be lapped not less than 6 inches and where laps are made at the ends of sheets, the longitudinal wires of the fabric shall be lapped not less than 12 inches. If the length of lap as set out herein is insufficient to permit the first wires parallel to the lapped joint of adjacent sheets to overlap, the length of the lap shall be increased so as to permit the overlapping of these wires. The position of the sheets with respect to transverse joints, longitudinal joints, and the edges of the pavement shall be as shown on the plans. All laps between sheets shall be held firmly together by means of tie wires or approved clips spaced not more than 4 feet apart. Steel fabric shall be installed by the strike-off method, wherein the first layer of concrete is deposited on the subgrade and struck off at the indicated depth below the finished surface of the pavement. The concrete shall be struck off by means of a mechanically operated strike-off templet of sufficient weight to prevent the wheels being lifted from the side forms when the templet is operated. The strike-off templet shall be approved by the engineer. The concrete shall be struck off to the entire width of the pour and to such length that the sheet of fabric may be laid full length on the concrete in its final position without further manipulation of the fabric. The fabric shall then be placed directly upon the concrete, after which it shall be covered with additional concrete in such quantity and so deposited and distributed that when finished the pavement shall have the required thickness and crown. The placing of the lower layer of concrete shall be followed promptly by the laying of the steel fabric and the placement of the upper layer of concrete. Any portions of the bottom layer of concrete which have been placed more than 15 minutes without being covered with the top layer shall be removed and replaced

with freshly mixed concrete at the contractor's expense. When the width of the pavement changes on curves, or at other points where it is impracticable to employ a mechanical strike-off templet, hand methods may be used, subject to the approval of the engineer. In case of breakdown or other emergencies, hand methods may be permitted at the discretion of the engineer, but only until repairs can be made.

5.34 Forming Joints:

Expansion joints, unless otherwise provided, shall be formed with wood filler or preformed filler, as provided elsewhere in these specifications, and sealed with asphalt mineral filler. Expansion joints, not less than ½ inch in width, shall be formed of preformed strips, meeting the requirements of Article 5.15 (b), about all existing or proposed structures and fixtures projecting through or into or against the pavement.

Longitudinal joints and transverse joints shall be constructed in all cases where and as indicated on the plans and construction joints shall be made as herein prescribed. Longitudinal joints shall be constructed in the manner shown on the plans. Transverse joints shall be expansion joints, dummy joints, construction joints or warping joints. Unless other locations are shown on the plans, all longitudinal joints shall be along or parallel to the center line of the pavement and all transverse joints shall be at right angles to the center line and shall extend the full width of the pavement. All joints shall be perpendicular to the surface of the slab and when tested with a straightedge, the surface across any joint shall not vary from the straightedge by more than ⅛ inch. Concrete edges at all joints except warping joints shall be tooled to the radius shown on the plans. All joints except warping joints shall be trimmed and filled with the prescribed material. Each kind of joint shall be of the type or variety and of the dimensions required by the plans or special provisions and shall conform in each case to the appropriate requirements hereinafter set forth.

5.35 Longitudinal Joints:

Longitudinal joints shall be constucted in accordance with the details shown on the plans. Tie bars of the dimensions shown and meeting the requirements of Article 5.12,

shall be placed across the longitudinal joints as shown on the plans. The tie bars shall be held in position, at the spacing shown, perpendicular to the joint and at the correct distance from the surface of the slab, by metal chairs or pins or other supports indicated on the plans or approved by the engineer. In lieu of using supports the tie bars may be floated in place by approved machine methods. In no case shall tie bars be painted, greased or otherwise treated to prevent bonding with the concrete.

The longitudinal joint shall be formed by impressing a groove or cleft in the slab, of the dimension shown on the plans. The groove formed in the soft concrete by a suitable tool or device shall extend horizontally along a line on or parallel to the center line of the pavement at the exact location shown on the plans. The groove shall extend vertically downward from the surface to the depth shown. The groove shall be filled with asphalt mineral filler in the manner specified under "Pouring Joints."

5.36 Transverse Joints:

Transverse joints shall consist of expansion joints, dummy joints, warping joints and construction joints, installed at intervals shown on the plans or provided herein, and constructed in conformity with the plan details and these specifications.

(a) Expansion Joints: Transverse expansion joints shall be formed during the placing of the concrete and such methods of construction shall be employed that joints to the full depth and width of the slab are secured. The finished joint shall be true to the line prescribed within an allowable variation of ¼ inch in the width of one traffic lane.

In the event dowels are used in expansion joints, the joint filler may be either wood filler meeting the applicable requirements of Article 5.14, or preformed filler meeting the requirements of Article 5.15 (b), as the contractor elects. In the event cantilever type units are used in expansion joints, the joint filler shall be wood filler meeting the applicable requirements of Article 5.14. In either event, the filler shall be cut to the required section. All filler shall be furnished in pieces of the required width and thickness, and not less than 5 feet in length, except where the joint for which the filler is intended is less than 5 feet long, the length of the piece shall be equal to the entire length of

the joint. Where more than one section is allowed and used in a joint, pieces of filler less than one lane width in length shall be laced or clipped together and all abutting ends of filler shall fit tightly together, so that no concrete can get into the joints. When in position, the filler shall be accurately perpendicular to the surface of the pavement. The bottom edge of the filler shall project to or slightly below the bottom of the slab and the top edge, unless otherwise prescribed, shall be held about ¾ inch below the surface of the proposed pavement to provide space for the sealing of the joint with a bituminous filler. The top edge of the filler shall be protected, while the concrete is being placed, by a metal channel cap of at least 10 gage material, having flanges not less than 2 inches in depth. The clear width between the flanges shall be 3/16 inch greater than the width of the filler. The channel cap and filler shall be securely held in place with the top thereof about ¼ inch below the proposed surface of the pavement in order to allow the finishing operations to be executed continuously.

In the event dowel bars are used for load transmission devices, holes shall be appropriately punched in the filler to admit the dowels. All holes for dowel bars shall be accurately spaced as specified on the plans and shall be of the same diameter as the bars to be placed therein.

In the event cantilever type units are used for load transmission devices, the assembled units shall be accurately installed at the spacing shown on the plans and in accordance with plan details. The units shall be accurately placed in each expansion joint and each unit shall be vertical with its length parallel to the center line of the road. The wood expansion joint filler shall be accurately notched to receive each unit. Cantilever type units installed at expansion joints shall have blocks of wood conforming to the above requirements for wood filler or of other material approved by the engineer, of proper dimension to fill the space at the end of the cantilever arm created by the assembly of the unit in an extended position.

After the concrete on both sides of the joint has been placed and struck off the channel cap shall be withdrawn. Unless otherwise directed, preference shall be given to the use of the protecting cap as a guide in edging the joints. After the removal of the protecting cap, the filler must be exposed for the full width of the slab. After the removal of the side forms, the ends of the transverse expansion

joints at the edges of the pavement shall be carefully opened for the entire depth of the slab.

Transverse expansion joints shall be sealed with asphalt mineral filler in the manner specified under "Pouring Joints."

(b) Dummy Joints: In the event dowel bars are used across dummy joints, the joints shall be formed by impressing a groove or cleft in the slab, of the dimension shown on the plans. The groove formed in the soft concrete by a suitable tool or device, shall extend across the width of the slab in a straight line and shall extend vertically downward from the surface to the depth shown. The groove shall be filled with asphalt mineral filler in the manner specified under "Pouring Joints." Dowel bars of the prescribed size shall be installed and accurately spaced all as provided by the plans. Dowels shall be painted at the site of work with one coat of red lead or basic sulphate blue lead paint. After the paint has dried and immediately before the bar is placed in position, it shall be coated with a heavy grease equivalent to 600W, or cup grease, to prevent bonding with the concrete.

In the event cantilever type units are used across dummy joints, the cleft or groove shall be prepared in the same manner as specified in the above paragraph. The units shall be installed in the closed position and in accordance with the details shown on the plans. The assembled units shall be accurately installed at the spacing shown on the plans and shall be firmly fastened to the wood assembly strip. Each unit shall be vertical with its length parallel to the center line of the road.

Assembly strips used with dowel bars shall be cut to the dimensions shown on the plans and may be either wood filler meeting the applicable requirements of Article 5.14 or preformed filler meeting the requirements of Article 5.15 (b), as the contractor elects. Assembly strips used with cantilever type units shall be wood filler meeting the applicable requirements of Article 5.14. In either event the assembly strip shall be placed directly under and in line with the dummy groove—failure to comply with this requirement will cause detrimental cracking and will be cause for rejection and the contractor will be required to remove and replace at his own expense all pavement, the joints of which fail to comply with this requirement.

(c) Warping Joints: Tie bars of the dimensions shown and meeting the requirements of Article 5.12, shall be placed across all warping joints, as shown on the plans. The tie bars shall be held in position, at the spacing shown, perpendicular to the joint and at the correct distance from the surface of each slab, by metal chairs or pins or other supports indicated on the plans or approved by the engineer. In lieu of using supports the tie bars may be floated into place by approved machine methods. In no case shall tie bars be painted, greased or otherwise treated to prevent bonding with the concrete.

Preformed filler shall be furnished in the dimensions shown on the plans and meeting the requirements of either type contained in Article 5.15, as the contractor elects. The strip shall be placed in the pavement, true and straight, in advance of the longitudinal float, to such depths as to allow the top edge of the strip to be not less than ¼ inch below the surface of the pavement. The preformed strips shall be placed in position by the use of a metal strip or by other mechanical means approved by the engineer.

(d) Construction Joints: Unless other prescribed joints occur at the same points, transverse construction joints shall be made at the end of each day's run or where interruption on the concreting operations of more than 30 minutes occurs and where the length of pavement laid from the last joint is more than 10 feet. Sections less than 10 feet in length between joints will not be permitted. A clean plank having a thickness of not less than 3 inches and cut to conform with the typical cross section of the slab may be used as a header board. The header board shall be accurately set and held in place in a plane perpendicular to the surface. The edge along the end of the pavement shall be finished with an edging tool of the radius shown on the plans. Upon resumption of work, the header board shall be carefully removed and any surplus concrete on the subgrade shall be cleaned away and the fresh concrete deposited directly against the old. Construction joints shall then be completed in accordance with the plans and in the same manner as prescribed hereinbefore for dummy joints.

5.37 Load Transmission Assemblies:

Load transmission assemblies may be either dowel assemblies or cantilever type assemblies as the contractor elects. In either event, they shall be prepared and placed

across all transverse joints, except warping joints, unless otherwise provided by the plans.

(a) Dowels: The dowel bars shall be held in position, parallel to the surface and center line of the slab, by an approved device which shall be left in the pavement. In lieu of this, the contractor will be permitted in the construction of dummy joints to vibrate the dowels in place by machine methods. The devices for holding the dowel bars in place shall be set near the ends of the bar (approximately 1 inch). By either method, the alignment of the bars after placement shall be true both horizontally and transversely. The plans show an acceptable dowel bar assembly for transverse expansion, construction and dummy joints. Other welded dowel bar assemblies of approved equal are acceptable. Each dowel bar placed in an expansion joint shall be provided with an approved close fitting, closed end metal sleeve, of the dimensions indicated on the plans, with suitable flange or other approved device to hold the end of the sleeve from the end of the bar during placing of the concrete so that a space of not less than the proposed thickness of the joint will be provided for subsequent movement of the bar in the sleeve. The type of metal sleeve to be used on the dowel bars for expansion joints must meet the approval of the engineer. The dowel bars shall be painted at the site of work with one coat of red lead or basic sulphate blue lead paint. After the paint has dried and immediately before the bars are placed in position in expansion joints the bars shall be completely coated on alternate opposite sides of the joint fillers with a heavy grease equivalent to 600W, or cup grease, applying it to that half of the bar with the capped end.

The dowel bars shall be of smooth round steel of a diameter and length shown on the plans and shall be placed as shown on the plans. The dowels shall not be burred at their ends.

(b) Cantilever Type Assemblies: Each cantilever type unit shall be assembled with a thin lubricating pad between the two castings comprising the unit. This pad, either of paper or similar material, shall be thoroughly lubricated before placing in the unit assembly. The device shall be assembled into a complete unit, including compression blocks when used in expansion joints, and the entire assembly shall be firmly held in position. The plans show an acceptable cantilever type assembly for transverse expan-

sion, construction and dummy joints. Other types of approved equal are acceptable. Joint braces, or other approved methods, shall be used to secure accurate alignment of the joint filler and the cantilever type load transfer units.

5.38 Butt Joints:

Butt joints, when required, shall conform to the details shown on the plans.

5.39 Pouring Joints:

Prior to the acceptance of the project and before pavement is opened to traffic, all expansion joints shall be sealed and all dummy and construction joints, cracks and fractures shall be filled with asphalt mineral filler. All joints, cracks and fractures shall be filled immediately after the curing operation is completed and all joints, cracks and fractures, together with any new cracks or fractures, shall be filled and kept filled with the specified filler until the entire project is completed and accepted by the engineer. Prior to the sealing of expansion joints, the top of the joint shall be thoroughly cleaned and the top edge of the joint filler trimmed with a special tool or device so that the top of the joint filler shall not be less than the required ¾ inch below the surface of the pavement. All joints shall be clean and dry before being poured and, in the event the impervious membrane method of curing the pavement is used, all joints, to their full depth, shall be thoroughly cleaned out with approved steel brushes. The poured filler shall be heated to such temperature that it will satisfactorily penetrate to the full depth and width of the joint. In pouring, the opening shall first be poured part full, allowed to settle and then completely filled. Any material spilled over the surface of the adjacent pavement, curbs or structures shall be immediately and completely removed by the contractor at his expense. After the pavement is opened to traffic, and prior to final acceptance, all filler in joints which extends above the surface of the pavement shall be trimmed flush with the pavement as often as directed by the engineer and to his satisfaction.

5.40 Consolidating and Finishing:

The sequence of operations shall be, first, the strike-off and consolidation; second, longitudinal floating, trans-

verse floating and removal of laitance; followed by straightedging and belting. Except where the work consists of paving city streets, the machine method of strike-off and consolidation shall be employed. Compacting and finishing by hand will be allowed only where machine finishing is impracticable. After a breakdown of the finishing machine, only material which is already in transit shall be finished by hand. All finishing tools and equipment shall be cleaned as often as required by the engineer.

Strike-off and Consolidation: The concrete as soon as placed shall be accurately struck off and screeded, with approved machine equipment, to the crown and cross section shown on the plans and to an elevation slightly above grade so that, when properly consolidated and finished, the surface of the pavement shall be at the exact grade elevation indicated by the plans and free from porous places.

The finishing machine shall be of the screeding and troweling type, designed and operated both to strike off and to consolidate. The machine shall go over each area of pavement as directed, as many times and at such intervals as necessary to give the proper compaction, and to leave a surface of uniform texture, true to grade and contour. At least 2 trips will be required, but if necessary to insure the required density and finish, additional screeding will be required. Prolonged operation over a given area shall be avoided. Where mechanical finishing is used, if the rate of depositing the concrete in the opinion of the engineer is in excess of the amount which the finishing machine can strike off and consolidate in full compliance with these specifications, a second finishing machine shall be provided and used. The compacting and finishing operations shall at all times be such as to produce a satisfactory surface in accordance with these specifications. If, in the opinion of the engineer, a satisfactory surface is not being produced, paving operations shall be stopped by the engineer and the contractor will not be permitted to proceed until satisfactory results are assured. The top of the forms shall be kept free from accumulations by an effective device attached to the finishing machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision of finish. The finishing machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable for loss of crown, or other derangement due to wear.

Hand Methods for Strike-off and Consolidation: When hand methods are permitted, concrete, as soon as placed, shall be struck off and screeded to the crown and cross section shown on the plans and to such elevation above grade that when consolidated and finished the surface of the pavement shall be at the grade elevation indicated on the plans. The entire surface shall then be tamped and the tamping operation continued until the required compaction and reduction of surface voids is secured. A strike-off or tamping templet, constructed to produce the pavement surface cross section indicated on the plans, shall be provided for this work. It shall be approximately 2 feet longer than the specified pavement width and shall consist of steel, or other suitable material shod with metal and be rigidly constructed to retain its shape under all working conditions. In making the strike-off above mentioned, the templet shall be moved forward on the 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 the side forms during the striking off process. All templets shall be subject to the approval of the engineer and shall be discarded when adjudged unfit for use.

Finishing Tools: After the concrete has been struck off, the contractor shall provide and use as hereinafter provided and directed by the engineer the following named tools: Longitudinal Float, Transverse Float, Straightedge Float, Bow Belt, Long Handle Float, Hand Float and Edging Tools. All tools for finishing the pavement and straightedges shall comply with the requirements of the Department's Standard Plan for Finishing Tools for Concrete Pavement unless other equipment is specifically permitted by the engineer. The continued use of tools other than those specifically provided for will not be permitted unless same is found to be effective for the purpose used. Any and all tools and equipment necessary for the finishing and checking of the pavement surface shall be furnished and used by the contractor as directed. Tools or equipment adjudged by the engineer as unfit for use shall be immediately discarded by the contractor.

Longitudinal Floating: After the concrete has been struck off and consolidated, it shall be further smoothed and consolidated by means of a mechanical longitudinal float.

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 twice, 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.

As an alternate to the above, the contractor may use a machine composed of a 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.

Transverse Floating: After longitudinal floating, any excess water and laitance shall be removed from the surface of the pavement transversely by means of either a 10-foot straightedge or a long-handled wood float having a blade not less than 5 feet in length and 6 inches in width. These 2 methods shall have preference in the order named, the first being used if conditions permit. Successive transverse drags of either tool shall be lapped ½ the length of the blade. The use of the long-handled wood float shall be confined to a minimum. It may be used behind the longitudinal float to correct surface unevenness not taken care of by the longitudinal float, but it shall not be used to float the entire surface of the pavement in lieu of, or supplementing, the use of the longitudinal float. When strike-off and consolidation are done by hand methods, and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled wood float. Care shall be taken not to work the crown out of the pavement during the operation.

Straightedging: After the longitudinal and transverse floating has been completed and the excess water removed, but while the concrete is still plastic, the slab surface shall be tested for trueness with a straightedge. For this purpose the contractor shall furnish and use an accurate 10-foot straightedge swung from handles 3 feet longer than ½ the width of the slab. The straightedge shall be held

in successive positions parallel to the road center line in contact with the surface 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. Straightedge testing and surface correction shall continue until the entire surface appears to conform to the required grade and contour.

Belting: When straightedging is completed and water sheen has practically disappeared and just before the concrete becomes nonplastic, the surface shall be belted with a suitable belt of 2-ply canvas, or other material acceptable to the engineer, approximately 6 inches wide and 2 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 center line and with a rapid advance parallel to the road center line.

Edging: Before the concrete has taken its initial set, the edges of the slab shall be carefully finished with an edger of the radius required by the plans, and the pavement edges shall be left smooth and true to line.

Finished Surface: The finished surface shall be free from porous spots, irregularities, depressions and small pockets or rough spots such as are or may be caused by accidental disturbing during the final finishing operations, or of particles of coarse aggregate embedded near the surface. Immediately after finishing is completed, channels through the shoulders or other means shall be provided to drain away surface water.

Surface Test: As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 10-foot straightedge or other specified device. Areas showing high spots of more than ⅛ inch, but not exceeding ¼ inch in 10 feet, shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of ⅛ inch when tested with a 10-foot straightedge. Where the departure from correct cross section exceeds ¼ inch, the pavement shall be removed and replaced by and at the expense of the contractor. Any area or section so removed

shall be not less than 10 feet in length nor less than the full width of the lane involved.

As soon as the side forms have been removed, any minor honeycombed areas shall be filled with mortar composed of one part cement to 2 parts of fine aggregate by weight. Major honeycombed areas will be considered as defective work and shall be removed and replaced at the expense of the contractor. Any area or section so removed shall be not less than 10 feet in length nor less than the full width of the lane involved.

5.41 Cold Weather Concreting:

Except by specific written authorization by the engineer, concreting operations shall not be continued when a descending air temperature in the shade and away from artificial heat falls below 40°F nor resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

When concrete is being placed during cold weather and the air temperature may be expected to drop below 35°F, a sufficient supply of straw, hay, grass or other suitable blanketing material shall be provided along the line of the work and at any time when the air temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete before it has thoroughly hardened. The contractor shall be responsible for the quality and strength of the concrete laid during cold weather and any concrete injured by frost action shall be removed and replaced at his expense.

5.42 Curing of Concrete:

After finishing operations have been completed the newly laid concrete shall be protected and cured by the wet earth, ponding, cotton mat, waterproofed paper, or the impervious membrane method, if Standard Portland cement has been used in the construction of the pavement; and if High Early Strength Portland cement has been used in the construction of the pavement, the concrete shall be protected and cured by the method of curing concrete constructed with High Early Strength Portland cement, all as hereinafter provided.

In all cases curing shall have prior rights to all water supply or supplies. Failure to provide sufficient approved cover material and maintain the protection as prescribed or lack of water supply capacity to take care of both curing and other requirements shall be cause for immediate suspension of concreting operations. Water shall be applied by a spray fine enough to avoid damage to the fresh concrete.

Cotton mats, burlap, waterproof paper and impervious membrane shall meet the respective requirements of Articles 5.18, 5.19, 5.20 and 5.21.

Wet Earth Method: Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered with wet burlap or wet cotton mats, laid directly upon the finished surface. The burlap or cotton mats shall be in a thoroughly wet condition when placed on the concrete and shall be kept continuously saturated with water both day and night, including Sundays and holidays, until removed. The manner of laying the burlap or cotton mats and the arrangement of the strips shall be as required by the engineer to best accommodate the necessary surface testing, joint trimming and other operations. The strips of burlap or cotton mats must be laid to overlap 6 inches or such greater overlap as the engineer may order to prevent occurrence of gaps or uncovered spots during the curing. After the forms are removed, the burlap or cotton mats shall be folded down and held in contact with the edges of the slab or the overhanging ends of the burlap or cotton mats folded back on top of the pavement so that the top surface of the slab is just covered and the edges of the slab cured by banking them with earth from the shoulders and keeping the banked earth wet. The covering of burlap or cotton mats, as the case may be, shall be removed, after the expiration of 24 hours, the slab thoroughly wetted, and the entire surface of the pavement covered with earth not less than 2 inches in depth and the exposed edges of the slab banked with a substantial berm of earth. In no case shall any concrete, at either the top or edge of slab, be left unprotected for more than ½ hour. The earth covering shall be thoroughly wetted while it is being placed on and against the sides of the slab and kept completely and continuously saturated. Curing shall continue for a period of 4 days dating from the time the slab is finished and the earth covering left saturated at the be-

ginning of the fifth day. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and resaturated. Upon approval of the Chief Engineer, in lieu of the earth covering, a cover of other suitable moisture retaining material may be used. Alternate cover material will be placed to the minimum depth and kept wetted as specified by the engineer. Cover material shall remain on the pavement for a period of not less than 7 days dating from the time the slab is finished and shall be removed only with the permission of the engineer. In no case shall traffic be permitted to use the concrete pavement until it has been cleaned and is free from the earth or other covering.

Ponding Method: When this method is used for curing, the initial curing shall be done with wet burlap or wet cotton mats, as provided in these specifications under the wet earth method of curing. The covering of burlap or cotton mats, as the case may be, shall be removed after the expiration of the 24 hours specified, and the entire surface of the pavement flooded with water which shall be ponded by means of a system of transverse and longitudinal dikes or dams of earth or other material. In no case shall any concrete, at either the top or edge of slab be left unprotected for more than ½ hour. Water shall be maintained at such depth that the pavement will be completely submerged throughout the period of curing. The edges of the slab shall be cured by banking them with earth from the shoulders and keeping the banked earth wet during the curing period. The curing shall continue for a period of not less than 4 days, dating from the time the slab is finished. Before the pavement is opened to traffic, the material composing the dams or dikes shall be removed from the surface and the pavement cleaned.

Cotton Mat Method: After completion of finishing operations, the surface of the pavement shall be entirely covered with wet cotton mats. The mats shall be placed as directed by the engineer in such a manner that the cotton mats will contact the surface of the pavement equally at all points. The mats shall be in a thoroughly wet condition when placed on the concrete and shall be kept continuously saturated with water both day and night. The curing shall continue for a period of not less than 4 days, dating from the time the slab is finished. The period of time the mats shall remain on the pavement may be extended by the engi-

neer if, in his opinion, weather or other conditions make it advisable to extend the curing period. After the forms are removed, the cotton mats shall be folded down and held in contact with the edges of the slab or the overhanging ends of the cotton mats folded back on top of the pavement so that the top surface of the slab is just covered and the edges of the slab cured by banking them with wet earth from the shoulders and keeping the banked earth wet.

Waterproofed Paper Method: When this method is used for curing, the initial curing shall be done with wet burlap or wet cotton mats, as provided in these specifications under the wet earth method of curing. The covering of burlap or cotton mats, as the case may be, shall be removed after the expiration of the 24 hours specified and the surface of the pavement shall then be entirely covered with waterproofed paper with the bleached side up. The paper shall be so placed and weighted as to cause it to remain in intimate contact with the surface of the pavement and separate units of the paper covering shall be lapped at least 18 inches. After removal of the forms the paper shall be folded down over the sides of the pavement and secured by a continuous bank of earth as a seal. The curing shall continue for a period of not less than 4 days, dating from the time the slab is finished. During the curing period the paper shall be maintained in intimate contact with the surface of the pavement.

Impervious Membrane Method: When this method is used for curing, the initial curing shall be done with wet burlap or wet cotton mats, as provided in these specifications under the wet earth method of curing. The covering of burlap or cotton mats, as the case may be, shall be removed after the expiration of the 24 hours specified and the entire surface of the pavement slab shall be covered with a single application of membrane curing compound. Curing compounds shall be thoroughly agitated during use and shall be uniformly sprayed, in a single application, by approved mechanically-powered, pressure spraying equipment on all concrete surfaces, at the specified rate of coverage recommended by the manufacturer and in no case to exceed 200 square feet per gallon. The curing shall continue for a period of not less than 7 days before opening to traffic, dating from the time the slab is finished. In the event rain should fall before the final set of the compound (dry to touch) it shall be re-applied as required herein.

If concrete surfaces have become dry, they shall be thoroughly moistened immediately prior to the application of the curing compound. Should the coating show any discontinuities or pin-holes, a second coat shall be applied immediately, at the same coverage called for in the initial application, wherever such defects are found. After removal of the forms, the edges of the slab shall be banked with earth from the shoulders, thoroughly wetted and left undisturbed, without additional wetting, for the duration of the curing period.

In the event of failure on the part of the contractor, through lack of facilities, or water supply, or for any other reason, under any of the above methods, to keep the burlap or cotton mats, as the case may be, in a thoroughly saturated condition during the curing period, paving operations shall be shut down until corrective measures are taken. In addition, pavement not satisfactorily cured for the above reasons may be ordered removed and replaced at the contractor's expense.

Method of Curing Concrete Constructed with High Early Strength Portland Cement: When High Early Strength Portland cement has been used in the construction of the pavement, the concrete shall be protected and cured by any of the methods provided herein for Standard Portland cement. In addition, burlap will be permitted for the entire curing period. The curing, by whatever method used, shall continue for a period of not less than 48 hours from the time finishing operations were completed.

Cold Weather Curing: When the average daily temperature is below 50°F, final curing by the above methods shall be omitted and the newly laid pavement shall be protected with not less than 12 inches of loose dry approved straw, hay, grass or other suitable blanketing material, which shall be maintained in place for 10 days.

5.43 Protection of Concrete:

The contractor shall erect and maintain suitable barricades and employ watchmen, if required by the engineer, to exclude traffic from the newly constructed pavement for the period herein prescribed but these barriers shall be so arranged as not in any way to interfere with or impede public traffic on any lane intended to be kept open and necessary signs and lights shall be maintained by the con-

tractor clearly indicating the open lanes. When it is necessary to provide for traffic across the pavement, the contractor shall at his expense construct suitable and substantial crossings to bridge over the concrete which will be adequate for the traffic and satisfactory to the engineer. When bridges or ramps are required, the contractor shall be required to construct same in the following manner: If it is necessary for trucks, tractors or similar heavy vehicles to cross the highway, a timber bridge shall be constructed without bearing on the pavement. If a crossing is required for automobiles, the contractor may bridge as specified above or construct an earth ramp, by first placing 12 inches of earth on the pavement and covering same full length with 2-inch planks placed paralled to the center line of the highway. However, no earth ramp shall be constructed until the pavement is at least 24 hours old, and then only in a manner as specified above.

Any part of the pavement damaged by traffic or other causes occurring prior to its final acceptance shall be repaired or replaced by and at the expense of the contractor in a manner satisfactory to the engineer. The contractor shall protect the pavement against both public traffic and the traffic caused by his own employees and agents. All ditches and drains shall be in such condition as to provide effective drainage. When berms of earth are placed along the shoulders, proper provision shall be made for surface drainage.

5.44 Black Traffic Stripes:

When so indicated on the typical sections of the plans or required by the special provisions, black synthetic iron oxide, meeting the requirements of Article 5.17, shall be applied at the required locations in the manner hereinafter specified so as to form traffic stripes of the required width, true to line and straight of edge.

Equipment: In order to produce the desired results, the contractor shall provide the necessary approved equipment which in general will consist of a set of parallel form plates or angles of ¼ to 5/16 inch thickness and suspended from a bridge or carrier mounted on wheels or supported on the pavement proper. The forms or guides shall be adjustable so that they may be raised or lowered. They shall be at least 6 feet long and spaced 6 inches apart.

The bottom edge of the angles shall be bevelled to a 45 degree angle with the inside face of the plates.

Application: Preparatory to placing the stripe, the guide shall be lowered so as to penetrate the surface of the concrete slightly. The surface of the concrete shall then be roughened between the guides by means of a small garden rake or similar device after which the required amount of the dry Iron Oxide shall be distributed or sprinkled evenly over the roughened surface and the surface rubbed with a wooden float until the coloring pigment penetrates the concrete for at least ⅛ inch over the entire width of the stripe. The Oxide shall be applied at the rate directed by the engineer but not to exceed 3 pounds of Oxide per 100 linear feet of 6-inch traffic stripe. The final surface of the stripe shall either be left slightly rough or troweled smooth as directed by the engineer. The alignment shall be void of any kinks or bulges and the contractor shall use suitable means of preventing the spilling of the Oxide on the surface not to be treated.

Curing and Protection: The curing of the pavement shall proceed as provided in Article 5.42, except that before the wetted burlap, or wetted cotton mats are applied, a 10-inch wide sheet of waterproof "butcher's" wrapping paper or equivalent shall be placed directly over the finished stripe to prevent discoloration from curing materials over the adjacent surface.

Further precautions must be exercised when windy to prevent the Oxide from blowing across the pavement. In case of rain, the stripe should be immediately covered with waterproof paper. The areas not treated during the shower can be treated as soon as possible after the shower provided the surface of the treated area is roughened with the use of a carborundum brick and additional cement applied and the coloring material worked into the green concrete with the carborundum brick.

5.45 Handling and Facilitating Public Traffic:

Normal, unimpeded use of the thoroughfare of which the proposed pavement is to be a portion or unit, is of value to the public and it is, therefore, mutually understood, under the contract of which these specifications form a part, that for the special sections of the thoroughfare stated in the special provisions and identified on the plans as requir-

ing special traffic handling and for the stated distances, commodious adequately surfaced road lanes shall be made available by the contractor for unimpeded public traffic at all times, and maintained in proper condition throughout the construction period. These lanes shall be of the clear widths indicated on the plans or stated in the special provisions, and shall be kept entirely free from encroachment at any time by any equipment of the contractor or by any workmen or employees of the contractor or by reason of storage or transportation of any materials intended for the work.

For the information of bidders, the desired scheme and sequence of construction of the several lanes, slabs and sections of pavement will be given on the plans, or stated in the special provisions, including information prescribing the sequence of the shifting of public lanes as necessary during progress of construction. The scheme and sequence when prescribed shall be followed in all details by the contractor.

Where the edge of any stipulated public traffic lane is contiguous to an edge of the particular slab or lane being placed, a substantial temporary guard fence shall be erected, as directed by the engineer, or as detailed on the plan, along the prescribed dividing line and maintained there until the slab is cured and opened to traffic. The fence shall be such as will effectually prevent workmen from moving into or standing on the public traffic lane, or impeding traffic. Workmen and employees of the contractor shall not be allowed to be in the reserved public lanes or in any way impede traffic at any time. The plan of operations and equipment of the contractor shall be such as to obviate any necessity of encroachment on the public traffic lane or lanes. Where so shown, special lanes for the contractor's trucks and similar vehicles shall be provided, separate from and not interfering with the prescribed public traffic lanes. Where the clearance between public traffic lane and the contractor's operating equipment is restricted, special delivery equipment may be necessary, designed to deliver and depart within the width of the slab actually being placed without encroaching on any public lane. Such equipment shall be provided when and if required by the plans or special provisions.

Except where a special contract price for "traffic handling" is included in the contract, all cost and extra

expense of such handling and protection, special equipment and temporary road surfacing and maintaining shall be at the expense of the contractor. Before making his bid, the contractor shall examine the site of these special traffic accommodations and give detailed consideration to the probable cost and extra expense to which he will be put, including the use of special equipment.

Attention is directed to Article 7.07 of Division I.

5.46 Split Slab Construction:

When required by the plans or in the special provisions, in order to adequately provide for and maintain traffic, the contractor will be required to construct the pavement slab ½ width at a time by the split slab construction method.

Longitudinal joints in pavement constructed by the split slab method shall conform to the details shown on the plans and the requirements of Article 5.35, except that placing tie bars by machine methods will not be permitted. Pavement constructed by the split slab construction method shall, in all other respects, conform to these specifications.

5.47 Pavement Widening and Transitions:

Where existing pavement slabs are to be widened, or where transition strips are to be constructed adjacent to existing slabs, such work shall be performed in accordance with the details shown on the plans and the requirements of these specifications.

Unless otherwise provided on the plans or in the special provisions, transverse joints in widening or transition strips shall match the joints in the existing pavement.

Unless otherwise provided in the special provisions, hand methods of consolidating and finishing the pavement in widening and transition strips will be permitted.

5.48 Opening to Traffic:

Traffic shall be excluded from newly constructed pavement, constructed with Standard Portland cement, for a period of 7 days after the concrete is finished (from pavement constructed with High Early Strength Portland cement, for a period of 48 hours) or longer if, in the opinion of the engineer, weather or other conditions make it advisable to extend the time, provided, however, that at

the discretion of the engineer cross bending test specimens, prepared at regular intervals from the mix as it comes from the mixer and cured under the same temperature, moisture and climatic conditions as the corresponding slabs of pavement, may be employed as a means of fixing the time of opening to traffic. These beams will be tested by standard laboratory methods and when these specimens under test indicate that the corresponding pavement has attained a modulus of rupture of not less than 600 pounds per square inch, the pavement shall be cleaned, the joints filled and trimmed and the pavement opened to traffic. In all cases the pavement shall be cleaned and the joints shall be filled and trimmed as herein required. The joint or line of separation between adjacent strips or slabs of concrete, when the pavement is constructed in lanes or strips, shall be cleaned and filled with bituminous material herein prescribed for the purpose.

5.49 Tolerance in Pavement Thickness:

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans. Where any pavement is found not so constructed, the following rules relative to replacement of the faulty pavement and adjustment of payment shall govern.

For pavement slab, the average thickness of which, determined as hereinafter provided, is equal, within ⅛ inch, to the thickness required by the typical cross section shown on the plans, the contract unit price shall be used in payment.

For pavement slab, the average thickness of which, determined as hereinafter provided, is less than the thickness shown on the plans by more than ⅛ inch, but less than ½ inch, an adjusted unit price shall be used in payment, which price shall bear the same ratio to the contract unit price as the square of the average thickness of the slab bears to the square of the thickness specified on the plans.

No additional payment over the unit contract price will be made for any slab, should the average thickness of the pavement, determined as hereinafter provided, exceed the thickness shown the plans, or in any case.

The thickness of the slab will be determined by average caliper measurement of the thickness of cores taken

from it. At such points as the engineer may select and in each 1,000 linear feet of pavement, 2 or more cores will be taken and measured. The average thickness of each full mile of slab, or any fraction of a mile, if the contract cannot be divided into an integral number of miles, will be determined from these measurements. An adjusted unit price shall be calculated for each mile or fraction and shall be used as the basis of payment for accepted yardage therein. In calculating the average thickness of the slab, measurements which are in excess of the thickness specified on the plans by more than ⅛ inch shall be considered as the specified thickness plus ⅛ inch, and measurements which are less than the specified thickness by ½ inch or more shall not be included in the average.

Payment shall be withheld for slab which is found deficient in thickness by ½ inch or more by excluding it from the accepted yardage. When the measurement of any core indicates that the slab is deficient in thickness by ½ inch or more, determination shall be made of the actual thickness of transverse sections of the slab at 25 foot intervals set off along the center line of the road in each direction from the affected location until, in each direction, a transverse section of the slab is found which is not deficient in thickness by as much as ½ inch. The area of slab for which no payment will be made shall be the product of the full width of pavement multiplied by the sum of the distances in each direction from the affected location along the center line of the road to the transverse sections found not deficient in thickness by as much as ½ inch.

With respect to slab, payment for which is withheld because of deficiency in thickness, if in the opinion of the engineer such deficiency is sufficient to seriously impair the traffic service expected from the pavement, the contractor will be required to remove such deficient areas and to replace them with slab of a satisfactory quality and thickness which when accepted, will be duly included in the pay yardage. The contractor, however, shall receive no compensation for materials or labor involved in the removal of the defective slab. If on the other hand, in the opinion of the engineer, there is no probability of immediate failure, he may allow the contractor the choice of leaving the defective slab in place and receiving no compensation or payment for same, or of removing and replacing the pavement

as provided above. All pavements more than one inch deficient in thickness shall be removed and replaced by the contractor at his own expense.

If the contractor believes that the cores and measurements taken are insufficient to fairly indicate the actual thickness of pavement, he may request additional cores and measurements. Such measurements shall be made at intervals of not less than 200 feet. The cost of additional cores and measurements shall be deducted from any sums due the contractor unless such measurements indicate that the slab within the area in question is of specified thickness.

Deductions for deficient thickness may be entered on any estimate after the information becomes available. No pavement shall be accepted until it has been duly cored and found within the ½-inch tolerance in depth.

5.50 Finishing Shoulders:

The construction, shaping and dressing of the shoulders shall follow the completion of the pavement as closely as practicable.

MEASUREMENT AND PAYMENT

5.51 Method of Measurement:

Portland cement concrete pavement, of the thickness shown on the plans, will be measured by the square yard, complete in place. The width for measurement will be the width from outside to outside of completed pavement, as constructed in accordance with the plans or as directed by the engineer. The length will be the actual center line length measured along the riding surface.

If shown on the plans, split slab construction will be measured by the square yard of pavement constructed by this method, complete in place and accepted. Measurement will be made in the same manner as provided above for the pavement slab.

If required by the plans, reinforcing steel will be measured as provided in Article 6.09, Part 4, Division II.

5.52 Basis of Payment:

The number of square yards of completed and accepted pavement, measured as provided above, shall be paid for at the contract unit price per square yard for "Portland Cement Concrete Pavement," complete in place, which

price and payment shall constitute full compensation for preparing the subgrade, shaping and compacting the shoulders, and for furnishing and placing all materials, including materials for all longitudinal joints, transverse joints and other joints, for traffic stripes, and all other material required by the plans and these specifications for the completion of the pavement slab, except reinforcing steel; for the furnishing of all forms, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item, and for all royalties and payments whatsoever for patents covering processes or equipment used in constructing the item.

Provided, that payment shall be withheld for slab which is found deficient in thickness by ½ inch or more from the thickness required by the typical cross section shown on the plans by excluding it from the accepted yardage, and provided that for slab which is found to be deficient by more than ⅛ inch but less than ½ inch from the thickness required by the typical cross section shown on the plans but is included in the accepted yardage, only the reduced price shall be paid as hereinbefore stated.

Payment will be made under:

Item 3-5-1, Portland Cement Concrete Pavement (9-7-9), per square yard.

Item 3-5-2, Portland Cement Concrete Pavement (8″ Uniform), per square yard.

Item 3-5-3, Portland Cement Concrete Pavement (9″ Uniform), per square yard.

Item 3-5-4, Portland Cement Concrete Pavement (10″ Uniform), per square yard.

Split slab construction, if provided for on the plans, measured as provided above, shall be paid for at the contract price per square yard for "Split Slab Construction," which price and payment shall constitute full compensation for the extra costs incurred by the contractor due to constructing the pavement slab by this method.

Payment will be made under:

Item 3-5-5, Split Slab Construction, per square yard.

Reinforcing steel installed in the pavement and accepted, measured as provided above, shall be paid for in accordance with Article 6.10, Part 4, Division II.

DIVISION II

Part 4—Structures

INDEX

PART 4—DIVISION II

SECTION 1

CONCRETE BRIDGES

1.01 Description:

This item shall consist of concrete bridges, including also, concrete slabs on steel bridges and concrete substructures for steel, timber and combination bridges, all of which shall be built and completed as indicated on the plans in conformity with the lines, profile grades, dimensions and design shown; in accordance with these specifications and in full compliance with the specifications for "Structural Excavation," Section 5, Part 1, Division II; "Concrete," Section 5, Part 4, Division II; "Bearing Piles," Section 1, Part 5, Division II; and other specifications or contract items which are to contribute to and constitute the complete structure or substructure in each case.

1.02 Equipment:

All equipment necessary for the proper mixing, placing and finishing of the concrete shall be on the project, in first class working condition, and shall have been inspected and approved before concreting operations will be permitted to begin. All equipment shall meet the specific require-

ments set forth under "Concrete" and "Reinforcing Steel," Sections 5 and 6, respectively, of Part 4, Division II, and "Bearing Piles," Section 1, Part 5, Division II.

MATERIALS

1.03 General:

The materials to be furnished and used shall be those prescribed for the several specifications and contract items which are to constitute the structure, including primarily, but not limited to, concrete and reinforcing steel.

CONSTRUCTION METHODS

1.04 Concrete:

The proportioning, mixing, placing, curing and finishing of concrete for bridges shall be performed in accordance with the specifications for "Concrete," Section 5, Part 4, Division II.

1.05 Foundations:

All foundations shall be prepared as specified under "Structural Excavation," Section 5, Part 1, Division II, and concrete shall not be placed until the foundation area upon which it is to rest has been inspected and approved by the engineer. All foundations shall be poured in the "dry" except as provided for under "Depositing Concrete Under Water," Article 5.19, Part 4, Division II, or unless otherwise permitted in writing by the engineer. Cofferdams and concrete seals shall be furnished and prepared as prescribed under "Structural Excavation," Section 5, Part 1, Division II.

1.06 Pile Heads:

The tops of timber piles shall project not less than 12 inches into the concrete after all damaged wood has been removed.

1.07 Drainage of Substructures:

The filling material back of abutments and wing walls shall be drained thoroughly and effectively by means of a system of tiling, French drains or other adequate con-

struction. Drains shall be so located that the stream water cannot wash away fill material through the openings. The drainage water shall be discharged through abutment, wing or pier walls in such manner and at such locations as to eliminate as far as possible any objectionable discoloration of exposed masonry surfaces. Drainage outlets shall be fitted with suitable screens where directed by the engineer and the intakes shall be protected against clogging by means of screens, gratings or French drains.

1.08 Placing Anchor Bolts:

All necessary anchor bolts in piers, abutments or pedestals shall be set carefully in Portland cement mortar in accordance with the requirements specified under "Steel Bridges," Article 2.07 of Section 2, Part 4, Division II.

The holes may be drilled in accordance with the provisions of the above mentioned article or, if in concrete masonry, may be formed by the insertion in the fresh concrete of oiled wooden plugs or metal pipe sleeves or other approved devices which are subsequently withdrawn after the concrete has partially set. When the holes are formed by the latter method, they shall be not less than 4 inches in diameter to allow for horizontal adjustment of the bolts. All such holes shall be adequately protected against the formation of ice in same while they remain open.

In lieu of the above methods of placing, anchor bolts in concrete masonry may be set to exact location in the concrete when it is placed. In this case great care shall be exercised to insure the proper setting of the bolts and any inaccuracies which will be detrimental to the structure shall be corrected by suitable means.

1.09 Setting Bed Plates:

Bed plates preferably shall be set on a layer of canvas and red lead as specified under "Steel Bridges," Section 2, Part 4, Division II.

1.10 Placing Superstructures:

No superstructure load shall be placed upon finished piers or abutments until the concrete has attained a flexural strength of 500 pounds per square inch or a compressive strength of 3,000 pounds per square inch, however, in any event, a minimum of 7 days shall have elapsed before

any superstructure load is placed upon finished piers or abutments. Tests for flexural and compressive strength of concrete shall be made in the same manner as provided under Method 1, Article 5.25, Part 4, Division II.

The method and sequence of placing concrete for the various types of concrete bridge construction shall be as specified below for the particular types of construction involved.

1.11 Reinforced Concrete Slab and Girder Bridges:

Concrete preferably shall be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers.

Concrete in girder haunches less than 3 feet in height shall be placed at the same time as that in the girder stems and the column or abutment tops shall be so shaped as 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.

Concrete in slab spans shall be placed in one continuous operation for each span. 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 shall be secured by means of suitable shear keys in the top of the girder stem. The size and location of these keys shall be as directed by the engineer. 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 be not 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.

Falsework and forms for all slab and girder spans shall be so constructed as to produce in the finished structure the camber indicated on the plans.

The concrete floor shall be poured symmetrically about the center line of the span. Care shall be taken to prevent the displacement of reinforcing steel during the placing of concrete.

If for any reason it becomes necessary to introduce a construction joint, this joint shall be formed by means of a vertical bulkhead so constructed as to produce a keyed or dove-tailed joint. In concrete floors not supported by longitudinal joists, any necessary construction joint shall be located at the center of the slab span.

The pouring of concrete floors on the various types of steel bridges shall proceed as follows:

(a) Steel Truss Spans: Beginning at the center and working simultaneously toward each end, or beginning at the ends and working simultaneously toward the center.

(b) Swing Spans: Beginning at the ends and working simultaneously toward the center.

(c) I-beam Spans: Beginning at the center and working simultaneously toward the ends, except on very short spans, where with the engineer's written permission, the contractor may use other methods.

(d) Where continuity over intermediate supports would occasion negative reactions at end supports of steel truss or I-beam spans, a length of deck at each end, sufficient to overcome any tendency to lift from the bearings, shall be poured first, or adequate temporary loads may be provided.

(e) Other Types of Structures: The sequence of construction shall be as shown on the plans.

1.12 Roadway Crown (Concrete and Steel Bridges):

The crown of the roadway shall be shown on the plans. Gutters shall be effectively drained by means of cast iron drain pipes of the dimensions and at the locations shown on the plans. The under surface of cantilever brackets and overhanging slabs shall be provided with a "V" groove ½ inch in depth, at a point not more than 6 inches from the outside face, for the purpose of arresting the flow of moisture and thus preventing staining.

1.13 Roadway Finish (Concrete and Steel Bridges):

The finishing of the roadway shall be performed as prescribed under "Concrete," Article 5.26 (g), Floated Surface Finish, of Part 4, Division II.

1.14 Waterproofing and Dampproofing:

When called for by the plans, concrete shall be waterproofed or dampproofed as designated, and it shall be performed in accordance with the requirements under "Waterproofing," or "Dampproofing," Sections 6 and 7 respectively, Part 5, Division II .

1.15 Concrete Viaducts:

Where concrete viaduct construction consists of a series of reinforced concrete slab or girder spans supported on bents or towers composed of concrete columns suitably braced by means of longitudinal and transverse struts and sway braces, the superstructure shall be constructed in accordance with the requirements governing the construction of concrete slab and girder structures. The following provisions relate to the construction of the column substructures.

Column forms may be of either steel or wooden material. Wood forms shall be composed of material not less than 1¼ inches in thickness after being dressed, or plywood not less than ¾ inch in thickness, as the contractor elects. Regardless of the type furnished, forms shall be effectively braced. Forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit of free access to the forms for the purpose of inspecting, working and spading the concrete.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least 12 hours before the caps are placed.

Unless otherwise permitted by the engineer, 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. In no event shall the load of the superstructure be allowed to come upon the bents until the requirements contained in the first paragraph of Article 1.10 have been met.

1.16 Concrete Railings:

In no case shall concrete railings be placed until the centering for the falsework for the span has been released, rendering the span self supporting. Concrete railings shall be constructed in accordance with the specifications for "Concrete Handrail" under "Handrails," Section 14, Part 5, Division II.

Railings Cast in Place: The portion of the railing or parapet which is to be cast in place shall be constructed in accordance with the requirements for "Concrete," Section 5, Part 4, Division II. Special care shall be exercised to secure smooth and tight fitting forms which can be rigidly held in line and grade and removed without injury to the concrete. Forms shall either be of single width boards or shall be lined with suitable material which shall meet with the approval of the engineer. Form joints in plane surfaces will not be permitted.

All mouldings, panel work, and bevel strips shall be constructed according to the detail plans with neatly mitred joints and all corners in the finished work shall be true, sharp and clean-cut and shall be free from cracks, spalls or other defects.

1.17 Expansion Joints:

Expansion joints shall comply with the specifications for "Expansion Joints" under "Concrete," Section 5, Part 4, Division II.

1.18 Black Traffic Stripes:

When indicated on the plans or required by the special provisions, traffic stripes shall be applied on the concrete deck at the exact location shown on the plans or as directed by the engineer, all in accordance with the requirements of Article 5.44, Part 3, Division II.

MEASUREMENT AND PAYMENT

1.19 Method of Measurement:

The quantities of concrete and of the various other pay items which constitute the completed and accepted structure will be measured for payment according to the specifications for the several individual contract items. Only accepted work shall be included and the dimensions

used shall be those shown on the plans or ordered in writing.

1.20 Basis of Payment:

The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items, complete in place, which prices and payments shall constitute full compensation for furnishing, hauling, and placing all materials, and for all labor, equipment, tools and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance shall be made for cofferdam construction, falsework, form lumber, or other erection expenses.

SECTION 2

STEEL BRIDGES

2.01 Description:

This item shall consist of steel bridges including but not limited to superstructures to be placed on concrete, steel or timber substructures, tower bents, etc., all of which shall be built and completed as indicated on the plans in conformity with the lines, profile grades, dimensions and design shown. All work shall be in accordance with these specifications and in full compliance with the specifications for "Structural Excavation," Section 5, Part 1, Division II; "Structural Steel," Section 7, Part 4, Division II; "Concrete," Section 5, Part 4, Division II; and other specifications or contract items which are to contribute to and constitute the complete structure in each case.

MATERIALS

2.02 General:

The materials to be furnished and used shall be those prescribed for the several specifications and contract items which are to constitute the structure, including primarily, but not limited to, structural steel.

Unless otherwise specified, the contractor shall make the chemical analyses and physical tests as stipulated in the applicable Standard Specifications of the A.S.T.M., and shall furnish the Testing and Research Engineer of the

Department of Highways, in Baton Rouge, with 7 copies of the certified reports of the chemical analyses and physical tests.

CONSTRUCTION METHODS

2.03 General:

The construction methods used shall be those prescribed for the several items which are to constitute the structure and in particular shall conform to the requirements for fabrication and erection, as hereinafter prescribed under "Structural Steel," Section 7, Part 4, Division II. No compensation for fabrication or erection of steel superstructure or structural steel shall be allowed except as provided under the aforementioned section covering structural steel.

Concrete: All concrete work specified on steel bridges shall comply with the requirements for the like class of work as specified under "Concrete Bridges," Section 1, Part 4, Division II.

2.04 Handling and Storing Materials:

Structural material, either plain or fabricated, shall be stored at the bridge site 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 kept 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.

2.05 Falsework:

The falsework shall be designed properly, constructed substantially and maintained for the loads which will come upon it. The contractor, if required, shall prepare and submit to the engineer for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the contractor's plans shall not be considered as relieving the contractor of any responsibility.

2.06 Erection of Steel:

Before starting the work of erection, the contractor shall inform the engineer fully as to the method of erection

he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the engineer. The approval of the engineer shall not be considered as relieving the contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the engineer has been obtained.

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 riveted fully and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings shall not be driven until the span has been swung. Splices and field connections shall have ½ of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have ¾ of the holes so filled. The steel structure shall be entirely riveted, except handrail, and swung before any concrete in the deck is poured.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be $\frac{1}{32}$ inch larger.

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 fitted up accurately and securely 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. Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank and shall have full bearing all

around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary they shall be drilled out.

Where bolted connections are specified, the bolts shall be considered as substitutes for rivets and all of the applicable requirements in regard to riveted connections shall apply to bolted connections.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the contractor. 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.

Field welding of steel structures, when authorized, shall conform to the current specifications for Welded Highway and Railway Bridges of the American Welding Society.

All operators to be employed on field welding of steel structures shall be qualified by tests as prescribed in the Specifications for Welded Highway and Railway Bridges of the American Welding Society. No field welding shall be performed by any operator who has not qualified in accordance with the provisions of this article.

The qualifying test welds shall be made under the supervision of the engineer and the specimen shall be prepared and tested by the laboratory. The Department will furnish the structural steel plates required but the contractor shall bear all other expense in making the following qualifying test welds:

TEST WELDS FOR CASE I

These test welds are as shown in Fig. D-22 of the American Welding Society Specifications and are to determine the operator's ability to make sound groove welds in material up to and including ¾" thick. Three test welds are to be made; one horizontal, one vertical, and one overhead. These test welds are to be made on all projects except when groove welds in material over ¾" thick are required, in which event the test welds for Case II shall be made.

TEST WELDS FOR CASE II

These tests welds are as shown in Fig. D-23 of the American Welding Society Specifications and are to

determine the operator's ability to make sound groove welds in material over ¾" thick. Three test welds are to be made; one horizontal, one vertical, and one overhead. These test welds are to be made on all projects where groove welds in material over ¾" thick are required. If test welds for Case II are required, the test welds for Case I are not to be made.

TEST WELDS FOR CASE III

These test welds are as shown in Fig. D-26 of the American Welding Society Specifications and are to determine the operator's ability to make sound fillet welds for all thicknesses of material. Two test welds are to be made; one vertical and one overhead. These test welds shall be made on all projects.

The Department will issue a certificate stating the results of the tests and the type of welds the operator is qualified to make. This certificate shall be good for one year from the date of issuance. However, the Department reserves the right to require requalification of the operator at any time subsequent to issuance of the certificate if the quality of the welds made by the operator are not satisfactory.

Other details of field assembling, placing, erecting, adjusting, straightening bent material, bolting, field riveting and other connections and adjustments of misfits shall be performed by the contractor in all respects as specified under "Structural Steel," Section 7, Part 4, Division II.

2.07 Bearing and Anchorage:

Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise provided, the bridge seat bearing area shall be swabbed thoroughly with red lead paint and then covered with 3 layers of 12 to 14 ounce duck, each layer being swabbed thoroughly on the top surface with red lead paint. The superstructure shoes or pedestals shall be placed in position while the paint is plastic. If indicated on the plans, sheet lead may be substituted for canvas and red lead.

The contractor shall drill the holes and set the anchor bolts, except where the bolts are built into the masonry.

The bolts shall be set accurately and fixed with Portland cement grout completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoe shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

2.08 Floors:

(a) Concrete Floors: Concrete floors shall comply with the requirements for this work under "Concrete Bridges," Section 1, Part 4, Division II.

(b) Plank and Laminated Floors: Plank and laminated timber floors shall comply with the specifications under "Untreated and Treated Timber," Section 8, Part 4, Division II.

(c) Steel Floors: Steel flooring shall comply with the specifications under "Open Grid Bridge Flooring," Section 9, Part 5, Division II.

MEASUREMENT AND PAYMENT

2.09 Method of Measurement:

The quantities of structural steel and the various other pay items, which constitute the completed and accepted structure, will be measured for payment according to the specifications for the individual contract items. Only accepted work shall be included and the dimensions shall be those on the plans or ordered in writing.

2.10 Basis of Payment:

The quantities of structural steel and of other pay items, measured as provided above, shall be paid for at the contract unit prices for the structural steel and the several other pay items, which prices and payments shall constitute full compensation for furnishing, preparing, fabricating, transporting, placing and erecting all structural steel and all other materials for the complete structure; for all shop work, painting and field work; for all labor, equipment, tools and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure ready for use, and no allowance shall be made for cofferdam construction, falsework, or other erection expenses.

SECTION 3

TIMBER BRIDGES

3.01 Description:

This item shall consist of timber structures built as indicated on the plans, in conformity with the lines, profile grades, dimensions and design shown, in accordance with these specifications and in full compliance with the specifications for "Untreated and Treated Timber," Section 8, Part 4, Division II; "Bearing Piles," Section 1, Part 5, Division II; and other specifications and contract items which are to contribute to and constitute the complete structure in each case.

MATERIALS

3.02 Timber and Lumber:

All timber and lumber to be used in timber bridges and fenders shall be Southern Pine or Douglas Fir (Coast Region), surfaced as indicated on the plans. It shall meet all of the requirements for materials under "Untreated and Treated Timber," Section 8, Part 4, Division II.

3.03 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 or wrought iron 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.

3.04 Structural Shapes, Etc.:

All structural shapes, rods and plates shall be of structural steel or wrought iron, as specified or called for on the plans, meeting the respective requirements prescribed under "Structural Steel," Section 7, Part 4, Division II. All castings shall conform to the requirements therefor prescribed under the aforementioned section for "Structural Steel."

CONSTRUCTION METHODS

3.05 General:

In addition to the requirements under construction methods of "Untreated and Treated Timber," Section 8, Part 4, Division II, the following specific requirements shall be adhered to in the construction of timber structures.

3.06 Workmanship:

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 under "Steel Bridges," Section 2, Part 4, Division II.

3.07 Framing:

All lumber and timber shall be accurately cut and framed to a close fit in such a manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

3.08 Pile Bents:

The piles shall be driven as accurately as possible in the correct location with a variation of the portion above the ground of not more than ¼ inch per foot from the vertical or batter indicated, or so that the cap may be placed in its proper location without inducing excessive stresses in the piles. Excessive manipulation of the piles will not be permitted and the contractor will be required to redrive or use other satisfactory methods to avoid such manipulations. No shimming on tops of piles will be permitted.

The piles for any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Cut-offs shall be accurately made to ensure perfect bearing between the cap and piles of a bent.

Pile heads shall be treated in accordance with the specifications under "Bearing Piles," Section 1, Part 5, Division II.

3.09 Caps for Bents:

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by driftbolts of not less than ¾ inch diameter, extending at least 9 inches into the posts or piles. The driftbolts shall be approximately in the center of the post or pile.

3.10 Bracing:

The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than ¾ inch diameter. Intermediate intersections shall be bolted, as indicated on the plans.

3.11 Stringers:

Stringers shall be sized at bearings and shall be placed in position so that knots near the edges will be in the top portions of the stringers. Outside stringers may have butt joints but interior stringers shall be lapped to take bearing over the full width of 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 driftbolting 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 at each end. All cross bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified in the contract, cross bridging shall be placed at the center of each span.

3.12 Floors:

Flooring on the roadway and sidewalk shall be of the type and dimensions shown on the plans.

3.13 Wheel Guards:

Wheel guards shall be constructed as shown on the plans. When the wheel guard is not blocked up from the

floor, drain holes shall be provided at such intervals as to drain the floor adequately.

3.14 Railings:

All railings shall be built as shown on the plans. Timber rails shall be squarely butt-jointed at the posts and the rails shall break joints.

Timber rails shall be painted as stipulated under "Painting," Article 4.01 (b), Part 5, Division II. Metal railing on timber bridges shall be painted as stipulated under "Painting," Article 4.01 (a), Part 5, Division II.

3.15 Holes for Bolts, Dowels, Rods and Lag Screws:

Holes for round drift bolts and dowels shall be bored with a bit $\frac{1}{16}$ 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 rods shall be bored with a bit $\frac{1}{16}$ 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.

3.16 Countersinking:

Countersinking shall be done wherever smooth faces are required. 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.

3.17 Bolts and Washers:

Washers of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood. Standard circular washers shall be used under the heads of all lag screws.

Where plans do not specify, $\frac{3}{4}$ inch and $\frac{5}{8}$ inch bolts shall have cast ogee washers and $\frac{1}{2}$ inch bolts shall have cut wrought iron washers, under both head and nut.

All bolts shall be effectively checked after the nuts have been finally tightened.

MEASUREMENT AND PAYMENT

3.18 Method of Measurement:

The quantities of timber and of the various other contract pay items which constitute the completed and ac-

cepted structure shall be measured for payment according to the specifications for the individual contract items. Only accepted work shall be included and the dimensions used shall be those shown on the plans or ordered in writing.

Hardware is not a pay item and no measurement will be made therefor.

Structural steel will be considered a pay item only when so indicated on the plans and when the contract includes a unit price for this item.

3.19 Basis of Payment:

The quantities measured as provided above, shall be paid for at the contract unit prices for the several pay items, which prices and payments shall constitute full compensation for furnishing, delivering, preparing, assembling and erecting all lumber, timber and other materials, for painting where required, and for all labor, equipment, tools and incidentals necessary to complete the work. Such payments shall constitute full payment for the completed structure, ready for use, and no allowance will be made for cofferdam construction, falsework, or other erection expenses.

SECTION 4

CULVERTS AND RETAINING WALLS

4.01 Description:

This item shall consist of reinforced concrete culverts, retaining walls and pipe headwalls, all of which shall be built and completed as indicated on the plans in true conformity with the lines, profile grades, dimensions and designs shown, in accordance with these specifications and in full compliance with the specifications for "Concrete," Section 5, Part 4, Division II, and with any other specifications or contract items which are to contribute to and constitute the complete structure in each case.

MATERIALS

4.02 General:

The materials to be furnished and used shall be those prescribed for the several specifications and contract items which are to constitute the completed structure. The ma-

terials and the composition and proportions for the concrete used in this item shall meet all the requirements specified under "Concrete" in Section 5, Part 4, Division II, for the particular class or classes of concrete shown on the plans.

CONSTRUCTION METHODS

4.03 Excavation:

All excavation involved shall be performed and all foundations and beddings shall be prepared as specified under "Structural Excavation," Section 5, Part 1, Division II.

4.04 Backfilling:

Backfilling for all retaining walls shall be as prescribed under "Structural Excavation," Section 5, Part 1, Division II.

Backfilling for pipe headwalls and culverts shall be as prescribed under "Excavation and Embankment," Section 4, Part I, Division II.

4.05 Foundation Fill:

If suitable foundation material is not encountered upon excavating to the required depth for a culvert, special rock or gravel backfill shall be furnished to replace the unsatisfactory material. The amount of foundation fill required shall be determined by the engineer. It shall be placed and built up in uniform layers, as directed, to the foundation elevation and thoroughly compacted. The cost of furnishing and placing foundation fill will be paid for by "Extra Work Order," as provided under Article 4.04, Division I.

4.06 Concrete:

(a) Class: All concrete used in culverts, retaining walls and pipe headwalls shall be Class A unless otherwise shown on the plans.

(b) Mixing, Placing and Finishing: Concrete used in this item shall be batched, mixed, placed and finished in accordance with the requirements of "Concrete," Section 5, Part 4, Division II. In addition, the following requirements for the placing of concrete in culverts shall apply:

All concrete shall be placed in the "dry."

In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case suitable provision shall be made for bonding the sidewalls to the culvert base, preferably by means of raised longitudinal keys so constructed as to prevent, as far as possible, the percolation of water through the construction joint.

Before concrete is placed in the sidewalls, the culvert footings shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully prepared in accordance with the method of bonding construction joints as specified under "Concrete" in Section 5, Part 4, Division II.

In the construction of box culverts 4 feet or less in height, the sidewalls and top slab may be constructed as a monolith. When this method of construction is used, any 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 before the top slab is placed. In this case, appropriate keys shall be left in the sidewalls for anchoring the cover slab.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line. Wing walls for culverts shall fill all the requirements for wing walls for abutments.

MEASUREMENT AND PAYMENT

4.07 Method of Measurement:

The quantities of the various contract pay items which constitute the completed and accepted structures will be measured for payment according to the specifications for the several individual contract items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

4.08 Basis of Payment:

The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items,

which prices and payments shall constitute full compensation for furnishing, hauling and incorporating all prescribed and necessary material in the structures, and for all labor, equipment, tools and incidentals necessary to complete the work. Such payment shall constitute full compensation for the complete structures, ready for use and shall include all excavation necessary to construct the structures, unless a pay item for such excavation is specifically provided on the plans. No additional allowance will be made for cofferdam construction, falsework, lumber or other erection expenses.

SECTION 5

CONCRETE

5.01 Description:

This item shall consist of concrete masonry composed of approved Portland cement, fine aggregate, coarse aggregate and water, prepared and constructed in accordance with these specifications, at the locations and of the form, dimensions and class shown on the plans or directed in writing by the engineer. The use of neither High Early Strength cement nor air-entrained cement will be permitted without the written consent of the engineer, except as may otherwise be provided in these specifications.

5.02 Equipment:

(a) Concrete Mixed at Site: Concrete shall be mixed thoroughly in a batch mixer of approved type and capacity with accurate timing and water measuring devices. The timing device shall be of the type which will automatically lock the discharging apparatus so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified time.

Minimum Size of Mixer: No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than 1-bag batch, except in the construction of pipe headwalls where a 3½ cubic foot mixer may be used.

In determining the capacity of mixers, the output per hour shall be as follows:

7 cubic foot mixer	3 Cu. Yds.
10 cubic foot mixer	7 Cu. Yds.
½ cubic yard mixer	10 Cu. Yds.
1 cubic yard mixer	20 Cu. Yds.

The maximum continuous pouring for the various sized mixers, unless otherwise permitted by the engineer, shall be as follows:

7 cubic foot capacity	35 Cu. Yds.
10 cubic foot capacity	70 Cu. Yds.
½ cubic yard capacity	100 Cu. Yds.

Under special conditions, and with satisfactory proof, the rating of mixers, as stated above, may be increased.

Blades: Pickup and throw over blades in the drum of the mixer which are worn down ¾ inch, or more, in depth must be replaced by new blades.

Unsatisfactory Mixers: When, in the opinion of the engineer, a concrete mixer is not adequate or suitable for the work, it shall be removed from the job and a suitable mixer provided.

(b) Ready-Mixed Concrete: Equipment required for ready-mixed concrete shall conform to the requirements for same contained in Article 5.31, Part 3, Division II.

MATERIALS

5.03 Portland Cement:

Portland cement shall conform to the requirements for Type I cement of the Specifications for Portland Cement, A.A.S.H.O. Designation: M 85.

5.04 High Early Strength Portland Cement:

High Early Strength Portland cement shall conform to the requirements for Type III cement of the Specifications for Portland Cement, A.A.S.H.O. Designation: M 85.

5.05 Water for Use with Cement:

Water for use with cement in mortar or concrete shall meet the following requirements:

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, when used in standard soundness, time of setting, and 1-3 mortar-strength test as outlined in Method of Test for Quality of Water to be Used in Concrete, A.A.S.H.O. Designation: T 26, with standard sand and cement, shall show no unsoundness; nor when compared with a similar test of distilled water using the same sand and cement shall it show a marked change in time of setting; shall show at least 95 per cent of the strength at 7 and 28 days of age. No water will be approved for use until a 7-day test has been completed.

5.06 Fine Aggregate:

This specification covers fine aggregate for cement concrete of all classes and types, and for mortar.

Sand shall consist of clean, hard, durable grains, graded from coarse to fine; it shall be 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:

	Per Cent, By Weight
Removed by decantation	3.0
Coal or lignite	0.25
Clay lumps	0.5

Fine aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the Reference Standard Color Solution, Method of Test for Organic Impurities in Sands for Concrete, A.A.S.H.O. Designation: T 21, shall be rejected.

Fine aggregate shall be uniformly graded from coarse to fine and shall conform to the following grading requirements:

Sieve Size	Per Cent Passing
⅜"	100
No. 4	95 to 100
No. 16	65 to 90
No. 50	7 to 30
No. 100, not more than	7
Sand for Mortar:	
No. 8	100
No. 50	15 to 40
No. 100	0 to 10

Strength: Fine aggregate when subjected to the mortar strength test, Method of Test for Compressive Strength of Hydraulic-Cement Mortars, A.A.S.H.O. Designation: T 106, shall show a strength 95 per cent of that developed using the same cement and standard Ottawa sand.

Local Sand Requirements: Preliminary tests of local sands shall only be considered as an indication of their quality. These tests will be made upon the request of any parties entitled to this consideration and samples need not be officially taken by representatives of the Department unless requested. In case the preliminary tests indicate that the sand is of the quality required for fine aggregate in concrete mixtures, it will be necessary to stock pile the material in not less than 200 cubic yard units in order that an official sample may be taken that will fairly represent the material proposed for use. When a smaller quantity is required to complete the work in which it is desired to use the material, or it is impracticable on account of local conditions to stock pile this quantity, the maximum amount possible to stock pile will be accepted as a unit. For stock piles larger than 200 cubic yards, one sample shall be taken from approximately every 200 cubic yards. The material in the stock pile will be sampled officially by representatives of the Department and forwarded to the laboratory for test purposes. Check tests will be made when requested in writing by the contractor, but the use of the material will be governed by the original test until subsequent test results are available.

5:07 Coarse Aggregate:

Coarse aggregate shall consist of gravel, crushed stone or a combination of gravel and crushed stone. Crushed slag may be substituted for gravel and/or crushed stone for the coarse aggregate for Class A concrete. When approved in writing by the engineer, crushed slag for coarse aggregate may be substituted for gravel and/or crushed stone in in other classes of concrete, however, in such event, the proportioning as provided in Article 5.10 will be fixed by the engineer.

Crushed slag aggregate shall be thoroughly clean and reasonably free from an excess of thin or elongated pieces or frozen lumps. It shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. The crushed slag shall weigh not less than 75 pounds per cubic foot, using Method of Test for Unit Weight of Aggregate, A.A.S.H.O. Designation: T 19. Because of its high absorption property, slag in stock piles shall be kept thoroughly wet.

All gravel shall consist of clean, tough, durable stone of high resistance to abrasion, free of clay coating of any character. "Run of Bank" gravel or gravel which contains disintegrated or soft stone or shale, or excess of flat pieces shall not be used. The gravel shall not contain more than 15 per cent of thin and elongated particles and shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. The maximum amounts of deleterious substances shall be as follows:

	Per Cent by Weight
Removed by washing	1.0
Clay lumps	0.5
Soft fragments	5.0
Iron Ore (Included in soft fragments	1.5
Maximum retained ¾″ — 0.5%	
Maximum passing ¾″ — 1.0%	
Coal and Lignite	1.0
Sticks (wet)	0.25
Totals, clay lumps, soft fragments, coal and lignite, and sticks shall not exceed	5.0

Aggregates used in hand rails shall be free from lignites.

Crushed stone shall be obtained from clean, tough, sound, durable stone. The particles of stone shall be free from dust, vegetable or other deleterious matter, and shall show a per cent of wear of not more than 40 by the Los Angeles abrasion test. The stone shall not contain more than 15 per cent of thin and elongated particles and not more than 3 per cent by weight shall be removed by washing over a number 8 sieve.

Gradation of Coarse Aggregates for Concrete: All coarse aggregate (gravel and/or crushed stone or crushed slag) shall be uniformly graded from coarse to fine, and when tested by means of laboratory sieves shall meet one of the following gradation requirements:

PER CENT OF COARSE AGGREGATE PASSING LABORATORY SIEVES

Grade	Square Opening in Inches					
	2½	2	1½	1	¾	No. 4
A			100	90–100	40–85	0–5
B		100	85–100		40–85	0–5
D	100	90–100		40–80		0–5

For Grade E mix 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 gradings of the 2 sizes of coarse aggregate may vary over a wide range so long as the combination of the two will give a grading when tested by laboratory square opening sieves within the following limits:

GRADE E

Sieve Size	Per Cent Passing
2½"	100
2½" to 1½"	25 to 40
1½" to ¾"	20 to 45
¾" to No. 4	20 to 35
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 aggregate for

Grade E shall not have more than 10 per cent retained on the 1-inch sieve, not less than 5 per cent on the ¾-inch and not more than 8 per cent passing No. 4. The larger size coarse aggregate for Grade E shall have 45 to 60 per cent retained on the 1½-inch sieve and shall not have more than 20 per cent passing the 1-inch sieve.

5.08 Premoulded Joint Filler:

Joint filler shall conform to the requirements of Article 5.15, Part 3, Division II. Either type may be furnished at the option of the contractor.

CONSTRUCTION METHODS

5.09 Classification:

Concrete shall be classified as Class A, Class D, Class R, or Class S. Each class of concrete shall be used in that part of the structure in which it is called for on the plans, or where directed. The following requirements shall govern unless otherwise shown on the plans.

Class A concrete shall be used for all parts of superstructures and for all parts of substructures (except where Class D or Class S concrete is stipulated) and for piling, retaining walls, concrete box culverts, pipe headwalls, counterweights and adjusting blocks, etc.

Class D concrete shall be used for pier footings and for unreinforced sections, as required by the plans.

Class R concrete shall be used for revetments and for other unreinforced sections, as required by the plans.

Class S concrete shall be used for all sections deposited under water, when so stipulated on the plans.

5.10 Proportioning:

(a) Cement and Aggregates: The proportions by volume, of cement to aggregates, measured separately, for the different classes of concrete shall be approximately as follows:

Class A Concrete (Gravel and/or Crushed Stone Coarse Aggregate)	1:5
Class A Concrete (Crushed Slag Coarse Aggregate)	1:5.15
Class D Concrete	1:6
Class R Concrete	1:8.5
Class S Concrete	1:4

The contractor shall vary, without charge, the ratio of fine to coarse aggregate as directed by the engineer, but in no case shall it be varied so as to materially affect 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 the following:

	Bags of Cement of 94 Lbs. each to one Cu. Yd. of Concrete
Class A Concrete (Gravel and/or Crushed Stone Coarse Aggregate)	6.0
Class A Concrete (Crushed Slag Coarse Aggregate)	6.2
Class D Concrete	5.0
Class R Concrete	4.1
Class S Concrete	7.0

Use of Cement: The contractor's attention is directed to the fact that the specified cement contents indicated in the above table are the minimum cement contents permitted but are not assured by the Department since the cement content obtaining from any type of mix is dependent upon the gradation of aggregates within the limits of the specifications for that type gradation. The cement content is based upon the most ideal combination and gradation of both fine and coarse aggregate.

(b) Water: The maximum amount of water per sack of cement permitted, including the free water in the aggregates, for the different classes of concrete shall not exceed the quantity shown in the following table. Free water shall be deemed to include all water entering the mix with the aggregate, except the water absorbed by the particles of aggregate.

Class A Concrete	5.5 Gallons
Class D Concrete	6.0 Gallons
Class R Concrete	8.0 Gallons
Class S Concrete	6.0 Gallons

5.11 Gradation of Coarse Aggregate:

Coarse aggregate for the various classes of concrete shall be of the grade shown in the following table and described in detail under "Materials:"

Class A Concrete—Grade A
Class D Concrete—Grade D
Class R Concrete—Grade A or Grade B or Grade D
Class S Concrete—Grade A

Different classes of coarse aggregate, or aggregates from different sources, even if tested and approved, shall not be mixed during use nor used alternately in any one class of construction except when permitted by the engineer in writing.

5.12 Handling, Measuring and Batching:

The aggregate shall be measured by weight, except for structures of less than 25 cubic yards, in which case the contractor may substitute approved volumetric measuring devices.

Concrete of the class indicated shall be made up of accepted material batched in the proportions set by the engineer for the specific materials. Corrections necessitated by variations from day to day in the moisture content of the raw materials or for other similar reasons shall be made as directed by the engineer.

The concrete mix will be designed with the intent of producing concrete which, when tested as prescribed in the Method of Test for Compressive Strength of Molded Concrete Cylinders, A.S.T.M. Designation: C 39, shall show a minimum compressive strength in pounds per square inch as follows:

	7 Days	28 Days
Class A Concrete.....	2,000	3,000
Class D Concrete.....	1,900	2,500
Class R Concrete.....	1,200	1,800
Class S Concrete.....	2,000	3,000

If the strength required for the class of concrete being produced is not secured with the minimum cement content specified, additional cement shall be used or other aggregate provided at the contractor's expense.

The engineer may require such additional samples from the concrete being placed for compression tests as necessary to determine that the mix proportions being used do produce the required strength.

The coarse and fine aggregate shall be handled and measured separately.

All cement shall be measured by weight. Cement packed in bags by the manufacturer shall be considered to weigh 94 pounds. Batches involving fractional bags will not be permitted. If bulk cement is used, separate scales and hoppers shall be used for the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container.

Water shall be measured either by volume or by weight. The allowable error in accuracy of water measuring equipment on the mixer shall be not more than ½ of one per cent. The equipment should preferably include an auxiliary tank from which the measuring tank shall be filled, and in any case shall be so arranged that the accuracy of measurement will not be affected by variations in pressure in the water supply line.

The allowable error in accuracy of weighing equipment for aggregates shall be not more than ½ of one per cent for all loads.

All weighing equipment shall be arranged so as to permit making compensation for changes in the weight of moisture contained in the aggregates and to permit the convenient removal of excess material, when weighing hoppers are provided.

Weighing equipment shall be so arranged that the operator has convenient access to all control levers and cables. The weighing beam and auxiliary weighing device shall be in full view of the operator when manipulating the gates which deliver material to the weighing hopper.

The scales shall be of either the beam or springless dial type. A suitable device consisting of a graduated beam or dial shall be used to register at least the last 100 pounds of either of the aggregates required for the batch. The value of the minimum graduation shall not be greater than 2 pounds. If the aggregate is measured by volume, the

contractor shall use satisfactory hoppers or boxes which when filled and struck off will give the exact volume of aggregate specified. In no case will wheelbarrow measurement be permitted.

5.13 Mixing at Site:

(a) Machine Mixing: The concrete shall be mixed only in such quantities as are required for immediate use. No retempering of concrete will be allowed. Aggregates or cement containing lumps or crusts of hardened material shall not be used.

Concrete shall be mixed for a period of not less than 1½ minutes after all materials, including water, are in the mixer.

During such period, the mixer shall operate at the speed for which it has been designed, but this speed shall be not less than 14 nor more than 20 revolutions per minute. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced. The materials composing a batch shall be deposited simultaneously in the mixer.

(b) Hand Mixing: Hand mixing will not be permitted, except in case of emergency and with the written permission of the engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be mixed thoroughly while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled into the center and the entire mass turned and sliced until a uniform consistency is procured. The coarse aggregate shall then be wetted thoroughly and added to the mortar and the entire mass turned and re-turned at least 6 times and until all of the stone particles are covered thoroughly with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed ½ cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

5.14 Ready-Mixed Concrete:

Ready-mixed concrete shall conform to the requirements of Article 5.31, Part 3, Division II.

5.15 Consistency:

The composition of the combined mixture shall be such as to produce concrete of maximum density consistent with workability, containing no free water, with the specified cement content, and not more than the volume of water specified in the table hereinbefore.

The quantity of water used shall not be changed without the consent of the engineer.

The consistency of the various classes of concrete shall be such as to have slumps within the following ranges when tested in accordance with the Method of Slump Test for Consistency of Portland Cement Concrete, A.S.T.M. Designation: C 143.

Class A Concrete	2—3 inches
Class D Concrete	1—3 inches
Class R Concrete	1—3 inches
Class S Concrete	4—8 inches

The above ranges represent the extreme limits of allowable slump. In all cases the amount of water used shall be the minimum necessary to secure the required workability of the concrete within the ranges of slump specified.

5.16 Falsework:

For designing falsework, a weight of 150 pounds per cubic foot shall be assumed for green concrete. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven and removed in a manner approved by the engineer. All spans shall be given sufficient temporary camber to allow for shrinkage and settlement. Bridges shall have a permanent camber only when shown on the plans. If appreciable settlement occurs in the falsework, the work shall be stopped and any masonry affected shall be removed and the falsework rebuilt. In general, double wedges or other suitable means shall be provided for con-

structing and maintaining falsework and forms to correct lines.

If requested by the engineer, detail drawings of the falsework shall be submitted to him for approval, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement.

5.17 Forms:

Forms shall be designed and constructed so that they may be removed without injury to the concrete.

All forms shall be of wood or metal and shall be built mortartight and of sufficient rigidity to prevent distortion due to 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.

Forms for exposed surfaces shall be made of either metal or dressed lumber of uniform thickness with or without a form liner of an approved type, and mortartight. Forms for re-entrant 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 and copings, to insure easy removal.

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. Column form marks shall be vertical and symmetrically placed. 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 immediatedy before placing the concrete.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit of free access to the forms for the purpose of inspecting, working, and spading the concrete.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 2 inches from the face without injury to the concrete. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least ½ inch from the face of the concrete with chisels or nippers; for green concrete, nippers are necessary. All 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 surface left sound, smooth, even and uniform in color.

All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be determined as hereinafter specified. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the engineer shall order the work stopped until the defects have been corrected.

The shape, strength, rigidity, watertightness 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.

All forms shall be treated with oil or saturated with water immediately before placing the concrete. For rail members or other members with exposed faces, the forms shall be treated with an approved oil to prevent the adherence of concrete. Any material 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 by the engineer immediately prior to placing concrete.

Cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

5.18 Placing Concrete:

No concrete shall be used which does not reach its final position in the forms within the following stipulated time:

(1) Concrete mixed at the site shall be placed in its final position within 45 minutes after the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate.

(2) Central- or transit-mixed concrete delivered in truck mixers or agitator trucks shall be placed in its final position within 60 minutes after the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate.

In hot weather or under other conditions contributing to quick stiffening of the concrete, the maximum allowable time specified herein may be reduced by the engineer.

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. The rate shall be such that the interval between batches shall not exceed 20 minutes. 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.

Pumping: Placement of concrete by pumping will be permitted only if specified in the special provisions or if authorized in writing by the engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. 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 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. After this operation, the entire equipment shall be thoroughly cleaned.

The method of placing shall be such as to avoid segregation of the aggregates or displacement of 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 conveyors, the engineer may order discontinuance of their use and a substitution of a satisfactory method of placing.

Where steep slopes are required, troughs and chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. When pipes are used they shall be kept full of concrete and have their lower ends kept buried in fresh concrete as required when a tremie

is used. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

When placing operations would involve dropping the concrete more than 5 feet, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face and to force the concrete under and around the reinforcement bars without displacing them. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

The placing of concrete shall be done in such manner that the steel reinforcement is not coated with cement before its final embedment. In depositing concrete around steel shapes and closely spaced reinforcing bars the concrete shall be deposited on one side of the steel and worked until it flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel.

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

(1) The vibration shall be internal unless special authorization of other methods is given by the engineer or as provided herein.

(2) Vibrators shall be of a type and design approved by the engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.

(3) The intensity of vibration shall be such as to visibly affect a mass of concrete of 1-inch slump over a radius of at least 18 inches.

(4) The contractor shall provide a sufficient number of vibrators to properly compact each 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 embedded 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 directly 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, and 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) The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

(9) The provisions of this article shall apply to precast piling, concrete cribbing and other precast members except that, if approved by the engineer, the manufacturers' methods of vibrations may be used.

Concrete shall be placed in each section of the work in a continuous operation working day and night, if necessary, to avoid stoppage planes. It shall be deposited in horizontal layers, placing thin layers at first that can be thoroughly worked into intimate contact with the concrete be-

neath. After a depth of 6 inches has been built up in this manner, the thickness of the layers may be increased to a maximum of 12 inches. The depth of layers used shall be such that the succeeding layer is placed before the previous layer has attained initial set. Each layer shall be compacted in a manner that will break up and obliterate any tendency to form a plane of separation between the layers. If it is necessary, by reason of an emergency, to stop placing concrete before any section is completed, bulkheads shall be placed as the engineer may direct. Any place where the placing of concrete is discontinued for a sufficient time to allow the concrete to take initial set shall be deemed a construction joint and treated as hereinafter described under "Forming Joints," Article 5.23.

Horizontal layers so located as to produce a construction joint at a location wherein a "featheredge" might be produced in the succeeding layer, shall be formed by inset work so that the succeeding layer will end in a body of concrete having a thickness of not less than 6 inches.

In no case shall the work on any section or layer be stopped or discontinued temporarily within 18 inches below the top of any face, unless the details of the work provide for a coping having a thickness of less than 18 inches, in which case, at the option of the engineer, the construction joint may be made at the under side of the coping.

Immediately following the discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcing steel and the surfaces of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset 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 at or near the surface of the concrete while cleaning the reinforcing steel.

After the concrete in finished surfaces has begun to set, it shall not be disturbed in less than 48 hours.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent. The method and sequence of placing concrete for the various types of concrete bridge construction shall be as specified in "Concrete Bridges," Section 1, Part 4, Division II, for the particular type of construction involved.

5.19 Depositing Concrete under Water:

Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

All concrete deposited under water shall be mixed in the proportions designated for Class S concrete.

Concrete deposited under water shall be placed carefully in a compacted mass in its final position by means of a tremie or tremies, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water and all form work designed to retain concrete under water shall be watertight. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation. To insure thorough bonding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set.

The tremie used shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the tremie over the entire work and to permit its being lowered rapidly when necessary to choke off or retard the flow. At the start of work, the tremie shall be plugged in such manner as to prevent water from entering the tube. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall it be interrupted until the work is completed.

Unwatering may proceed when the concrete seal is sufficiently hard and strong. 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.

5.20 Air-Entrainment:

The use of concrete with air-entrainment will be permitted only with the written approval of the engineer.

When permitted, either of the following approved methods for obtaining air-entrainment may be used:

1. The use of normal Portland cement meeting the requirements of Article 5.03 with approved admixture introduced at the mixer.

2. The use of air-entraining Portland cement meeting the requirements of the Specifications for Air-Entraining Portland Cement, A.A.S.H.O. Designation: M 134.

Air-entraining additions shall conform to the requirements of the Specifications for Air-Entraining Additions for use in the Manufacture of Air-Entraining Cement, A.A.S.H.O. Designation: M 149.

Regardless of the method used for obtaining air-entrainment, the amount of the entrained air shall be not less than 3 per cent nor more than 6 per cent.

If Method 1 is used to obtain air-entrained concrete, the admixture shall be added at the mixer in an amount determined in the laboratory. The contractor will be required to follow an approved procedure for adding the specified amount of air-entraining admixture to each batch and will be held responsible for its uniform operation during the progress of the work. The contractor shall provide separate approved scales for such admixtures as are to be proportioned by weight and accurate measures for such admixtures as are to be proportioned by volume. The admixture may be added either mechanically or manually. If added mechanically, the dispenser shall be approved by the engineer. If added manually, proper control shall be exercised and the engineer may require that the additive be mixed with water.

In the event Method 2 is used the engineer shall determine whether the cement when used in the required proportions will entrain air in the concrete within the limits specified. In case the air content, thus determined, falls outside the specified range and it is found impossible to obtain the required air content by slight adjustments in the fine-coarse aggregate ratio and/or by changes in mixing procedures, the contractor may, if the air content is too low, use an air-entraining admixture of the same type as that used in the manufacture of the air-entraining cement,

in an amount sufficient to bring the air content within the required range. If the air content is too high, the contractor, subject to approval by the engineer, may use a non-air-entraining cement as a replacement for a portion of the air-entraining cement in an amount sufficient to bring the air content within the required range.

Prior to and during construction the engineer will require testing of the air-entrained concrete for the determination of its compressive strength as deemed necessary. When so tested, the compressive strength of air-entrained concrete at 7 days, made under either method, shall not be less than 88 per cent of the strength of concrete made with the same materials and with the same cement content and consistency, but with normal Portland cement without the admixture.

The mixing time and the design of the mix shall be in accordance with all requirements of these specifications, except that the volume of fine aggregate and the amount of mixing water should be reduced sufficiently to avoid the bulking effect caused by the entrained air. In general the mix should be redesigned by decreasing the volume of sand by an amount equal to the net change in the volume of air plus water. Or, in other words, the volume of sand should be reduced by the amount required to obtain the same yield and cement content.

Concrete with air-entrainment shall conform to all other applicable requirements of these specifications.

5.21 Wet Batching:

Wet batched concrete shall consist of concrete mixed at the batching plant and hauled to the point of use in open trucks. In order to prohibit excessive hauling the batching plant shall be set up within the limits of the project. The use of wet batching shall be limited to the construction of short culvert extensions and headwalls, pipe headwalls, and incidental structures, as directed by the engineer, unless otherwise provided on the plans or in the special provisions.

The bodies of trucks used for hauling wet batched concrete shall be smooth and watertight and shall be equipped with gates that will permit of control of the discharge of the concrete. Watertight covers shall be provided for protection against the weather when required.

The concrete shall be delivered to the site of work in a thoroughly mixed and uniform mass and discharged with a satisfactory degree of uniformity. Segregation of the materials and difficulty in discharge upon delivery will result in the rejection of the wet batched concrete.

The contractor will be required to use air-entrained admixtures in wet batched concrete. The use of concrete with air-entrainment shall conform to the requirements of Article 5.20.

Wet batched concrete shall conform to all other applicable requirements of these specifications.

5.22 Cold Weather Concreting:

Except by written authorization of the engineer, concreting operations of mixing and placing shall not be continued when a descending atmospheric temperature in the shade and away from artificial heat falls below 40°F nor resumed until an ascending atmospheric temperature in the shade and away from artificial heat reaches 35°F. If such authorization is granted, the aggregates shall be heated by either steam or dry heat to a temperature of not less than 70°F nor more than 150°F. The water shall be heated to a temperature of between 130°F and 150°F. The temperature of the mixed concrete shall be not less than 60°F nor more than 100°F at the time of placing it in the forms. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing. When directed by the engineer, the contractor shall furnish sufficient canvas and framework, or type of housing, to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature above 50°F for a period of 5 days after the concrete is placed. Sufficient heating apparatus, such as stoves, salamanders or steam equipment, and fuel to furnish all required heat, shall be supplied. The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material.

The contractor shall assume all risk in connection with placing concrete in cold weather and permission given to place concrete under the above conditions shall in no way relieve the contractor of responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory it shall be removed and replaced at the contractor's expense.

5.23 Forming Joints:

(a) Construction Joints: The location of construction joints shall be planned in advance and shall be subject to approval by the engineer. The placing of concrete shall be carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear. When the work of placing concrete is delayed until the concrete has taken initial set, the point of stoppage shall be deemed a construction joint.

At all horizontal construction joints and at other locations, when directed, a gauge strip not less than 2 inches thick shall be placed inside the forms along all exposed faces to give the joint a straight line and to eliminate wedge shaped particles of concrete that might chip off. In placing concrete up to construction joints, the forms shall be "over filled" at least one inch and all excess material removed, including all laitance.

In joining fresh concrete to concrete that has already set, the forms shall be drawn tight against the face of the set concrete and all gage strips and key forms removed. The surface of the set concrete to be contacted shall then be cut over with suitable tools to remove all residual laitance and loose and foreign material. This surface shall then be washed and scrubbed with wire brooms, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the old surface shall be coated thoroughly with a very thin coating of neat cement mortar.

(b) Keys: In order to bond successive courses, suitable keys shall be formed at the top of the upper layer of each day's work and at other levels where work is interrupted. These keys shall be formed by the insertion and subsequent removal of beveled wood strips which shall be saturated thoroughly with water prior to insertion. Steel dowels may, at the discretion of the engineer, be used in lieu of keys. All construction joints shall be keyed or doweled as shown on the plans or as directed by the engineer.

(c) Sliding Joints: Sliding joints shall be true planes parallel to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders or beams, or between walls, etc., the surface of the supporting concrete shall be given a smooth finish and covered with 2 layers of 3-ply roofing felt to separate the concrete.

(d) 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 templet 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.

(e) Filled Joints: Filled expansion joints shall be constructed similar to open joints. When premoulded types are specified, the filler shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed. Metal water stops shall be carefully placed as shown on the plans.

(f) Steel Joints: 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 requirements of these specifications covering those items. When called for on the plans or in the special provisions the material shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free from 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 in any manner.

(g) Water Stops: Metal water stops shall be furnished and placed as provided on the plans. They shall be spliced, welded, or soldered, to form continuous watertight joints.

(h) Special Joints: Special watertight and flashed expansion joints shall be constructed as shown on the plans.

5.24 Curing Concrete:

Careful attention shall be given by the contractor to the proper curing of finished concrete surfaces. Such surfaces shall be protected, within 12 hours of placing, by a covering of canvas, straw, burlap, sand or other satisfactory material which shall be kept wet by flushing or sprinkling for a period of not less than 10 days after placing of the

concrete. Other precautions to insure the proper development of strength shall be taken as the engineer may direct.

Unless otherwise permitted by the engineer, concrete bridge floors shall be closed to traffic for a period of at least 14 days after placing and for such additional time as may be considered advisable.

5.25 Removal of Forms and Falsework:

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. In order to facilitate slab finishing, forms for inside curb faces on roadway slabs may be removed in not less than 3 hours provided the concrete has set sufficiently and forms are constructed in a manner to permit their removal without damage to the curbs.

The following specifications for the removal of forms and falsework from portions of structures which do not require surface finish shall apply to the forms and falsework under 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 regardless of whether or not those surfaces are required to be finished.

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 flexural strength or compressive strength, as determined by either beam or cylinder tests, indicated in the following table:

Class of Concrete	Required Flexural Strength Lbs. per Sq. In.	Required Compressive Strength Lbs. per Sq. In.
A.....	500	3,000
D.....	400	2,500

Test specimens shall be made from the same concrete and cured under the same conditions as the portion of the

structure involved. For the test beams, the Method of Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading), A.S.T.M. Designation: C 78, shall be used, except the test beam will be made in the field and sampling of concrete for molding specimens and storing of the test beams shall be done in the same manner as provided for the test cylinders. For the test cylinders, the Method of Test for Compressive Strength of Molded Concrete Cylinders, A.S.T.M. Designation: C 39, shall be used.

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:

Forms and falsework under slabs or girders having span length of 10 feet and less	7 days
Forms and falsework under slabs or girders having span lengths over 10 feet and less than 17 feet	7 days plus one day for each foot of span over 10 feet
Forms and falsework under slabs or girders having spans over 17 feet in length	14 days
Forms and falsework under the portion of slabs that cantilever more than one foot beyond the outside beams	4 days
Forms and falsework under caps or tie beams of framed bents	5 days
Forms under caps of pile bents	2 days
Forms and falsework under webwalls of piers	7 days
Forms for walls, columns, sides of beams and under slabs that cantilever one foot or less beyond the outside beam	2 days
Forms for concrete caissons	2 days

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. If 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 the 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, and the materials used in the mix.

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. In general, the forms shall be removed from the bottom upwards. Forms and their supports shall not be removed without the approval of the engineer. 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 by the engineer.

5.26 Finishing Concrete:

(a) General: Surface finishes shall be classified as follows:

Class 1—Ordinary surface finish.
Class 2—Rubbed finish.
Class 3—Tooled finish.
Class 4—Sand blasted finish.
Class 5—Wire brushed or scrubbed finish.
Class 6—Floated surface finish.
Class 7—Sidewalk finish.

All concrete shall be given Class 1, Ordinary Surface Finish, and in addition, if further finishing is required, such 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 piers, abutments, wing walls and retaining walls; the outside faces of girders, T-beams, slabs, columns, brackets, curbs, headwalls, railings, arch rings, spandrel walls and parapets; but not on 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. The surface finish on piers and abutments shall include all exposed surfaces below bridge seat to one foot below low water elevation or 2 feet below finished ground line when such ground line is above the water surface. Wing walls shall be finished from the top to 2 feet below the finish slope lines on the outside face and shall be finished on top and for a depth of one foot below the top on the back sides.

Unless otherwise specified, roadway floors shall be given Class 6, Floated Surface Finish, and sidewalks shall be given Class 7, Sidewalk Finish.

(b) 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 exposed 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 for a period of not less than 3 hours shall be carefully 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 mortar patches shall be cured as specified under "Curing." All construction joints 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 resultant surface shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the engineer shall be "rubbed" as specified for Class 2, Rubbed Finish.

(c) 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 for a minimum period of 3 hours. 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 the 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 pastes 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. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

(d) Class 3, Tooled Finish: Finish of this character for panels and other like work may be secured by the use of a bushhammer, pick, crandall, or other approved tool. Air tools, preferably, shall be employed. No tooling shall be done until the concrete has set for at least 14 days and as much longer as may be necessary to prevent the aggregate particles from being "picked" out of the surface. The finished surface shall show a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

(e) Class 4, Sand Blasted Finish: The thoroughly cured concrete surface shall be sand blasted with hard, sharp sand to produce an even fine-grained surface in which the mortar has been cut away, leaving the aggregate exposed.

(f) Class 5, Wire Brushed or Scrubbed Finish: This type of finish shall be produced by scrubbing the surface of a green concrete with stiff wire or fiber brushes, using a solution of muriatic acid in the proportion of 1 part acid to 4 parts water. As soon as the forms are removed and while the concrete is yet comparatively green, the surface shall

be thoroughly and evenly scrubbed as above described until the cement film or surface is completely removed and the aggregate particles are exposed, leaving an even pebbled texture presenting an appearance grading from that of fine granite to coarse conglomerate, depending upon the size and grading of aggregate used. As soon as the scrubbing has progressed sufficiently to produce the texture desired, the entire surface shall be thoroughly washed with water to which a small amount of ammonia has been added to remove all traces of the acid.

(g) Class 6, Floated Surface Finish:

Striking Off: After the concrete is compacted as specified under Article 5.18, the surface shall be carefully rodded and struck off with a strike board to conform to the cross section and grade shown on the plans. Proper allowance shall be made for camber, if required. The strike board shall be operated longitudinally and shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. A slight excess of concrete shall be kept in front of the cutting edge at all times.

Floating: After striking off and consolidating as specified above, the surface shall be made uniform by longitudinal or transverse floating, or both. Longitudinal floating will be required except in places where this method is not feasible.

Longitudinal Floating: The longitudinal float, operated from foot bridges, shall be worked with a sawing motion while held in a floating position parallel to the road center line and passing gradually from one side of the pavement to the other. The float shall then be moved forward ½ of its length and the above operation repeated. Machine floating which produces equivalent results may be substituted for the above hand method.

Transverse Floating: The transverse float shall be operated across the pavement by starting at the edge and slowly moving to the center and back again to the edge. The float shall then be moved forward ½ of its length and the above operations repeated. Care shall be taken to preserve the crown and cross section of the pavement.

Straightedging: After the longitudinal floating has been completed and the excess water removed, but while the concrete is still plastic, the slab surface shall be tested

for trueness with a straightedge. For this purpose, the contractor shall furnish and use an accurate 10-foot straightedge swung from handles 3 feet longer than ½ the width of the slab. The straightedge shall be held in successive positions parallel to the road center line and contact with the surface and the whole area gone over from one side of the slab to the other as necessary. Advance along the deck 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. The straightedge testing and refloating shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab has the required grade and contour, and until there are no deviations of more than ⅛ inch under the 10-foot straightedge.

Final Finishing: When straightedging is completed and the concrete has hardened sufficiently, the surface shall be given a belt finish. The belt shall be of an approved type, of 2-ply canvas or other material acceptable to the engineer, approximately 6 inches wide and 2 feet longer than the width of the slab. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road center line and with a rapid advance parallel to the road center line.

The surface as thus finished shall be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidental disturbing, during the final finishing operations, of particles of coarse aggregate embedded near the surface.

(h) Class 7, Sidewalk Finish: After the concrete has been deposited in place, it shall be compacted 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. Sidewalk surfaces shall be laid out in blocks with an approved grooving tool as shown on the plans or as directed by the engineer.

5.27 Drainage and Weep Holes:

Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the engineer. Drains and weep holes in the faces of the abutments shall be connected with the roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown or directed.

Forms for weep holes through concrete may be clay pipe, concrete drain pipe, or wooden boxes. If wooden forms are used they shall be removed after the concrete is placed. Drain pipes embedded in concrete shall be standard light weight cast iron water pipe or wrought iron pipe. The pipe shall be held rigidly against displacement during the placing of the concrete.

MEASUREMENT AND PAYMENT

5.28 Method of Measurement:

The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No measurement or other allowance will be made for forms, falsework, cofferdams, pumping, bracing or expansion joint material. No measurement or allowance will be made for structural excavation unless otherwise specifically provided on the plans.

No deductions in quantities of concrete shall be made for the enclosed reinforcing bars in counterweights and adjusting blocks, but the volume of structural steel so enclosed shall be deducted from the volume of concrete. Measurement will be based on the actual dimensions of the finished counterweights, including adjusting blocks.

No deductions will be made for the volume of reinforcing steel, small pipes and conduits, steel angles forming armored joints in roadway slabs, weep holes or cast iron drains.

Deductions will be made for the volume of steel beams and beam and girder flanges embedded in concrete, for all expansion joints, and for all pile heads embedded in concrete. In computing the volume to be deducted for con-

crete pile heads embedded in concrete, nominal butt dimensions, that is, 12 inches x 12 inches, 14 inches x 14 inches, etc., shall be used. In computing the volume to be deducted for timber piles embedded in concrete, a butt diameter of 12 inches shall always be used, regardless of size and length of pile.

5.29 Basis of Payment:

The number of cubic yards of completed and accepted concrete of the several classes, measured as provided above, shall be paid for at the contract price per cubic yard for Class A, Class D, Class R, or Class S Concrete, as the case may be, complete in place, which price and payment shall constitute full compensation for the concrete; for all materials, including expansion joint filler, weep holes and cast iron drains indicated on the plans and for the installation of all joints, weep holes, and cast iron drains; for all timber bumpers, forms, falsework, placing and finishing; for all labor, tools, equipment and incidentals necessary to complete the item; but shall not constitute payment for reinforcing steel, nor for metal expansion joints. Payment will not be made for structural excavation except as provided under "Method of Measurement."

No extra payment will be made for steel punchings used in counterweights and adjusting blocks, cost of same to be included in price bid on concrete.

Metal expansion joints shall be paid for as pounds of structural steel complete in place and accepted.

Reinforcing steel shall be paid for under the pay item of that name.

Concrete in counterweights will be paid for as "Class A Concrete in Counterweights," when shown on the plans, as provided in Article 8.20, Part 5, Division II.

Payment will be made under:

Item 4-5-1, Class A Concrete, per cubic yard.
Item 4-5-2, Class D Concrete, per cubic yard.
Item 4-5-3, Class R Concrete, per cubic yard.
Item 4-5-4, Class S Concrete, per cubic yard.

SECTION 6

REINFORCING STEEL

6.01 Description:

This item shall consist of furnishing and placing reinforcing steel of the quality, type, size and quantity designated, in accordance with these specifications and as shown on the plans.

The grades and types of reinforcing steel shall, unless otherwise shown on the plans, be as follows:

(a) Structures: Reinforcing steel for structures, including counterweights, shall be deformed bars, of new billet steel or rail steel.

(b) Concrete Paving: Reinforcing steel for concrete paving shall be either wire mesh or bar mat reinforcement, as indicated on the plans.

MATERIALS

6.02 Bar Reinforcement:

Bar reinforcement for concrete shall conform to the requirements of the Specifications for Billet-Steel Bars for Concrete Reinforcement, A.A.S.H.O. Designation: M 31, and the Specifications for Rail-Steel Bars for Concrete Reinforcement, A.A.S.H.O. Designation: M 42, with the following modifications:

(1) All bars shall be of the deformed type conforming to the requirements of the Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement, A.S.T.M. Designation: A 305, unless otherwise specified.

(2) The use of cold twisted bars will not be permitted.

(3) Steel for all bars shall be made by the open-hearth process unless otherwise called for in the special provisions or on the plans.

Testing: All physical tests of bars shall be made at the Department's laboratory, unless otherwise specified. Testing of bars shall be in accordance with the Methods of Tension Testing of Metallic Materials, A.A.S.H.O. Designation: T 68.

After the steel is delivered to the site, the engineer shall select one sample, 36 inches long, of each size and

type bar from each consignment of 30 tons or less and forward same to the Department's testing laboratory for testing purposes.

6.03 Wire and Wire Mesh:

Wire shall conform to the Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, A.A.S.H.O. Designation: M 32.

Wire mesh, when used as reinforcement in concrete shall conform to the Specifications for Welded Steel Wire Fabric for Concrete Reinforcement, A.A.S.H.O. Designation: M 55. The type of mesh shall be as shown on the plans or approved by the engineer. Wire mesh for use as fabric reinforcement for concrete paving shall be furnished in flat sheets. Any sheets which may become bent or distorted must be straightened and otherwise put in proper condition before using. When placed in the work, the fabric shall be free from excessive rust, scale or coating of any character which will prevent its bond with the concrete.

Testing: All physical tests of wire mesh shall be made at the Department's laboratory unless otherwise specified. Testing of wire and/or wire mesh shall be made in accordance with the Methods of Tension Testing of Metallic Materials, A.A.S.H.O. Designation: T 68.

After the wire mesh is delivered to the site, the engineer shall select samples 36 inches by 36 inches, from each carload or less, and forward same to the Department's testing laboratory for testing purposes.

6.04 Bar Mat Reinforcement:

Bar mat reinforcement shall conform to the Specifications for Fabricated Steel Bars or Rod Mats for Concrete Reinforcement, A.A.S.H.O. Designation: M 54.

Samples and tests shall be the same as provided for steel bars in Article 6.02.

6.05 Structural Shapes:

Structural shapes used as reinforcement in concrete shall conform to the requirements for structural steel as provided in Section 7, Part 4, Division II.

CONSTRUCTION METHODS

6.06 General Requirements:

(a) Order Lists: When bill of materials and bending diagrams are not shown on the plans, all order lists and bending diagrams shall be furnished by the contractor for the approval of the engineer, and no materials shall be ordered until such lists and bending diagrams have been approved. The approval of order lists and bending diagrams by the engineer shall in no way relieve the contractor of responsibility for the correctness of such lists and diagrams. Any expense incident to the revision of material furnished in accordance with such lists and diagrams to make it comply with the design drawings shall be borne by the contractor.

(b) Protection of Material: Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil or other foreign substance. However, when steel has, on its surface, detrimental rust, loose scale and dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the engineer.

(c) Approval of Reinforcement Placing: Placing and fastening of reinforcement in each section of the work shall be approved by the engineer before any concrete is deposited in that section.

(d) Fabrication: Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the following requirements:

Stirrups and tie bars shall be bent around a pin having a diameter not less than 2 times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than 6 times the minimum thickness except for bars larger than one inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars having cracks or splits at the bends shall be rejected.

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.

6.07 Structures:

(a) Placing and Fastening: All steel reinforcement shall be accurately placed in the positions shown on the

plans and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing is less than one foot in each direction when alternate intersections shall be tied.

Reinforcement in any member shall be placed and then inspected and approved by the engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions or approved metal chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted.

(b) Splices: 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 the written approval of the engineer.

Unless otherwise shown on the plans, to make the splice, bars shall be lapped 35 diameters. 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 required minimum clear distance to other bars and the required minimum distance to the surface of the concrete.

(c) Welding: Welding of reinforcing steel shall be done only if detailed on the plans or if authorized by the engineer in writing. Welding, when permitted, shall conform to the current specifications for Welded Highway and Railway Bridges of the American Welding Society.

(d) Substitutions: Substitution of different size bars will be permitted only with specific written authorization by the engineer. If steel is substituted, it shall have an area equivalent to the design area, or larger.

6.08 Concrete Pavement:

Wire mesh reinforcement and bar mat reinforcement shall be placed in accordance with the requirements of Article 5.33, Part 3, Division II.

MEASUREMENT AND PAYMENT

6.09 Method of Measurement:

Steel reinforcement incorporated in the concrete masonry will be measured in pounds based on the total computed weight for the sizes and lengths of bars, mesh or mats as shown on the plans or authorized.

The weight of mesh will be computed from the theoretical weight of plain wire. If the weight per square foot is given on the plans, that weight shall be used.

The weight of plain or deformed bars or bar mat will be computed from the theoretical weight of plain round or square bars of the same nominal size as shown in the following table:

Bar No.	Effective Diameter in Inches	Equivalent Square Bar Size, Inches	Overall Diameter in Inches	Weight Per Foot Pounds	Area in Square Inches
2*.....	¼	.....	0.25	0.167	0.05
3.....	⅜	.....	0.43	0.376	0.11
4.....	½	.....	0.55	0.668	0.20
5.....	⅝	.....	0.68	1.043	0.31
6.....	¾	.....	0.81	1.502	0.44
7.....	⅞	.....	0.94	2.044	0.60
8.....	1	.....	1.07	2.670	0.79
9†.....	1.13	1	1.23	3.400	1.00
10†.....	1.27	1⅛	1.38	4.303	1.27
11†.....	1.41	1¼	1.53	5.313	1.56

*Bar No. 2 in plain rounds only, not deformed.

†Bars Nos. 9, 10 and 11 are round bars and equivalent in weight and nominal cross section to square bars of 1", 1⅛" and 1¼" sizes respectively.

The weight of reinforcement used in railings, when they are paid for on a linear foot basis, shall not be included. The weight of reinforcement in precast piles and other items where the reinforcement is included in the contract price for the items shall not be included.

No allowance will be made for clips, wire, separators, wire chairs, and other material used in fastening the reinforcing in place. If bars are substituted upon the contractor's request and as a result more steel is used than specified, only the amount specified shall be included.

When laps are made for splices, other than those shown on the plans, for the convenience of the contractor, the extra steel shall not be included.

Reinforcing steel furnished for testing purposes shall not be included.

Structural shapes used as reinforcement shall be measurd as provided for under "Structural Steel," Section 7, Part 4, Division II.

6.10 Basis of Payment:

The number of pounds of completed and accepted reinforcing steel, measured as provided above, shall be paid for at the contract unit price per pound for "Deformed Reinforcing Steel," "Plain Reinforcing Steel," "Wire Mesh Reinforcement," or "Bar Mat Reinforcement," as the case may be, which price and payment shall constitute full compensation for furnishing, bending, delivering, fabricating and placing all of the reinforcing steel, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Item 4-6-1, Deformed Reinforcing Steel, per pound.
Item 4-6-2, Plain Reinforcing Steel, per pound.
Item 4-6-3, Wire Mesh Reinforcement, per pound.
Item 4-6-4, Bar Mat Reinforcement, per pound.

Structural shapes used as reinforcement shall be paid for as provided under "Structural Steel," Section 7, Part 4, Division II.

SECTION 7

STRUCTURAL STEEL

7.01 Description:

This item shall consist of furnishing, fabricating, preparing, assembling, erecting and painting (both shop and field) of all structural steel, wrought iron, steel castings and forgings, rivet steel, gray iron and malleable iron castings, bronze castings or plates, anchor plates and anchor bolts, steel plates, and shapes for expansion joints and pier protection, pipes and drains in steel superstructures and in floors thereof (except for those features for which other payment is provided), all in accordance with these specifi-

cations and with the applicable requirements prescribed for "Steel Bridges," Section 2, Part 4, Division II, "Concrete Bridges," Section 1, Part 4, Division II, "Concrete," Section 5, Part 4, Division II, and "Painting," Section 4, Part 5, Division II, and in conformity with the dimensions, shapes and designs shown on the plans.

MATERIALS

7.02 General:

Except where otherwise provided, all members of steel structures shall be of structural carbon steel and structural rivet steel.

Unless otherwise specified, all steel forgings required by the plans shall be of carbon steel, Class C-1.

7.03 Structural Steel:

(a) Structural Carbon Steel and Eye Bar Steel: Structural carbon steel and steel for eye bars shall conform to the requirements of the Specifications for Steel for Bridges and Buildings, A.S.T.M. Designation: A 7.

(b) Structural Silicon Steel: Structural silicon steel shall conform to the requirements of the Specifications for Structural Silicon Steel, A.S.T.M. Designation: A 94. Welding will be permitted in the conditioning of surface imperfections in accordance with Paragraph 2 (c).

(c) Structural Low-Alloy Steel: Structural low-alloy steel shall conform to the requirements of the Specifications for Low-Alloy Structural Steel, A.S.T.M. Designation: A 242.

(d) Structural Nickel Steel: Structural nickel steel shall conform to the requirements of the Specifications for Structural Nickel Steel, A.S.T.M. Designation: A 8.

(e) Structural Welding Steel: Structural welding steel shall conform to the requirements of the Specifications for Structural Steel for Welding, A.S.T.M. Designation: A 373.

7.04 Rivet Steel:

(a) Structural Rivet Steel: Structural rivet steel shall conform to the requirements of the Specifications for Structural Rivet Steel, A.S.T.M. Designation: A 141.

(b) High-Strength Structural Rivet Steel: High-strength structural rivet steel shall conform to the re-

quirements of the Specifications for High-Strength Structural Rivet Steel, A.S.T.M. Designation: A 195.

7.05 Copper Bearing Steels:

When copper bearing steel is specified, the steel shall contain not less than 0.2 per cent of copper.

7.06 Steel Forgings:

(a) Carbon Steel Forgings: Carbon steel forgings shall conform to the Specifications for Carbon Steel Forgings for General Industrial Use, A.S.T.M. Designation: A 235, Class C-1.

(b) Heat-Treated Forgings: Heat-treated forgings, where specified, shall conform to the Specifications for Carbon Steel Forgings for General Industrial Use, A.S.T.M. Designation: A 235, Class G.

(c) Alloy Steel Forgings: Where alloy steel forgings from which pins for use with structural silicon steel members to be fabricated, are specified, these forgings shall conform to the Specifications for Alloy Steel Forgings for General Industrial Use, A.S.T.M. Designation: A 237, Class A.

7.07 Wrought Iron:

(a) Wrought Iron Plates: Wrought iron plates shall conform to the Specifications for Wrought Iron Plates, A.S.T.M. Designation: A 42.

(b) Rolled Wrought Iron Shapes and Bars: Rolled wrought iron shapes and bars shall conform to the Specifications for Rolled Wrought Iron Shapes and Bars, A.S.T.M. Designation: A 207.

(c) Welded Wrought Iron Pipe: Welded wrought iron pipe shall conform to the Specifications for Welded Wrought-Iron Pipe, A.S.T.M. Designation: A 72. The pipe shall be standard galvanized unless otherwise shown on the plans.

7.08 Steel Castings:

(a) Carbon Steel Castings: Carbon steel castings shall conform to the Specifications for Mild-to-Medium-Strength Carbon-Steel Castings for General Application, A.S.T.M. Designation: A 27, Grade 70-36.

(b) Chromium Alloy Steel Castings: Chromium alloy steel castings shall conform to the Specifications for Corrosion-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application, A.S.T.M. Designation: A 296, Grade CA-15.

7.09 Gray Iron Castings:

Gray iron castings shall conform to the Specifications for Gray Iron Castings, A.S.T.M. Designation: A 48, Class No. 30, unless otherwise specified.

Iron castings shall be true to pattern in form and dimensions, 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 arrises shall be sharp and perfect.

All castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

7.10 Malleable Castings:

Malleable castings shall conform to the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47, Grade No. 35018.

Malleable castings shall be true to pattern in form and dimensions, 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 arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

All castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

7.11 Bronze or Copper-Alloy Bearing and Expansion Plates:

(a) Bronze Bearing and Expansion Plates: Bronze bearing and expansion plates shall conform to the Specifications for Bronze Castings for Bridges and Turntables, A.S.T.M. Designation: B 22, Alloy B.

(b) Rolled Copper-Alloy Bearing and Expansion Plates: Rolled copper-alloy bearing and expansion plates shall con-

form to the Specifications for Rolled Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Uses, A.S.T.M. Designation: B 100, Alloy No. 1.

7.12 Paint:

All paint materials shall comply with the requirements under "Painting," Section 4, Part 5, Division II.

7.13 Testing Structural Members and Eye Bars:

Full-Size Tests: When full-size tests of built-up structural members and eye bars are required by the contract, the contractor shall supply testing machines of the proper type and capacity and shall provide all facilities and labor incidental to the making of tests. In all tests involving the determination of tensile and compressive strengths, the ultimate strength, deformation and other pertinent data shall be recorded.

Number and Size of Test Bars: When tests of full-sized eye bars are required, the number and size of the bars to be tested shall be designated by the engineer before the mill order is placed. The number shall not exceed 5 per cent of the whole number of bars ordered, with a minimum of 2 bars on small orders.

Selection of Test Bars: Test bars shall be of the same section as the bars to be used in the structure and of the same length if within the capacity of the testing machine. They shall be selected by the inspector from the finished bars, preferably after annealing. Test bars representing bars too long for the testing machine shall be selected from the full-length bar material after the heads on one end have been formed and shall have the second head formed upon them after being cut to the greatest length which can be tested.

Failure to Meet Requirements: If an eye bar fails to fulfill the specified requirements, 2 additional bars of the same sizes and from the same melt shall be tested. The bars represented by the test may be reannealed before the additional bars are tested. If 2 of the 3 test bars fail to give satisfactory results, the bars of that size and melt shall be rejected.

Record of Annealing: A record of the annealing charges shall be furnished the engineer showing the bars included in each charge and the treatment they received.

CONSTRUCTION METHODS

7.14 Fabrication:

(a) Shop Drawings: The contractor shall furnish the engineer shop detail plans of all steelwork for approval, and no fabrication shall be started prior to final approval of these plans. These details must conform to the general drawings, stress sheets and specifications, and no deviations from the approved shop plans will be allowed without the 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 by the engineer.

Shop drawings shall be 22 inches by 36 inches in size, and shall be made in ink on tracing cloth. Two blue print copies of each drawing shall be submitted to the Bridge Design Engineer of the Department of Highways, in Baton Rouge, for checking, one of which will be returned with either approval or required revisions noted thereon. When changes on submitted drawings are requested by the engineer and the contractor makes additional changes, other than those expressly requested, he shall direct attention to them on the next copies of blue prints submitted by underscoring with colored crayon or other suitable means. For final approval, the contractor shall submit 9 blue print copies. Upon completion of fabrication, the original tracings shall be delivered to the Bridge Design Engineer of the Department of Highways in Baton Rouge. The final estimate will not be approved for payment until the original tracings have been delivered to the Bridge Design Engineer.

The contractor will be permitted to deliver reproductions on cloth, of a permanent type, from which legible prints can be made, of the original tracings, if he prefers. If the contractor elects to deliver reproductions on cloth, the original tracings may be made in any manner the contractor prefers, providing satisfactory reproductions on cloth can be made from the original tracings.

If the structural steel on the project consists only of expansion dams and bearing assemblies, the contractor will not be required to deliver the original tracings or reproductions.

(b) Type of Fabrication: Riveted construction is intended, unless otherwise indicated.

(c) Quality of Workmanship: Workmanship and finish shall be equal to the best general practice in modern bridge shops.

(d) Storage of Materials: Structural material, either plain or fabricated, shall be stored at the bridge shop 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.

(e) 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. Sharp kinks and bends shall be cause for rejection of the material.

(f) Finish: Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately.

(g) Rivet Holes: All holes for rivets shall be either punched or drilled. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched $\frac{1}{16}$ inch larger than the nominal diameter of the rivets whenever the thickness of the metal is not greater than $\frac{3}{4}$ inch for structural steel or $\frac{5}{8}$ inch for alloy steel.

When there are more than 5 thicknesses or when any of the main material is thicker than $\frac{3}{4}$ inch in carbon steel, or $\frac{5}{8}$ inch in alloy steel, or when required under (j), all the holes shall be subpunched or subdrilled $\frac{3}{16}$ inch smaller and, after assembling, reamed $\frac{1}{16}$ inch larger, or drilled from the solid to $\frac{1}{16}$ inch larger, than the nominal diameter of the rivets.

(h) Punched Holes: The diameter of the die shall not exceed the diameter of the punch by more than $\frac{1}{16}$ inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

(i) Reamed or Drilled Holes: Reamed holes shall be cylindrical, perpendicular to the member and not more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivets. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be $\frac{1}{16}$ inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. Poor matching of holes will

be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the engineer, 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.

(j) Subpunching, Reaming and Shop Assembly: Unless otherwise specified, holes in all field connections and field splices of main truss or arch members, continuous beams, plate girders and rigid frames shall be subpunched [or subdrilled if subdrilling is required according to (g)], and reamed while assembled in the shop. The assembly, including camber, alignment, accuracy of holes and milled joints, shall be approved by the engineer before reaming is commenced.

Unless otherwise authorized by the engineer, each individual (full length) truss, arch, continuous beam or girder shall be assembled in the shop before reaming is commenced.

All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel templet or reamed while assembled.

If additional subpunching and reaming is required, it shall be specified in the special provisions or on the plans.

(k) Accuracy of Punched and Subdrilled 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 $\frac{1}{8}$ 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 per cent 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 $\frac{3}{16}$ inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

(l) Accuracy of Reamed and Drilled Holes: When holes are reamed or drilled, 85 per cent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than $\frac{1}{32}$ inch between adjacent thicknesses of metal.

(m) Shop Assembling: Shop assembly of trusses, arches, continuous beam spans and plate girders shall be according to (j).

Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated designs shall be done when shown on the plans or when stipulated in the special provisions.

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 $\frac{1}{16}$ inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

(n) Camber Diagram: A camber diagram shall be furnished the engineer, showing the camber at each panel point for each truss, taken from actual measurements while the truss is assembled.

(o) 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 rivets, they shall be reamed.

(p) 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.

(q) Rivets: 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 diameter of rivet. They shall be full,

neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

(r) Bolts and Bolted Connections:

1. General: Bolted connections shall not be used unless shown on the plans or specifically authorized by the engineer. Where bolted connections are permitted, the bolts furnished shall be unfinished bolts (ordinary rough or machine bolts). Turned bolts, special ribbed bolts, or high tensile bolts, shall be provided if shown on the plans or if required by the special provisions.

All bolts and nuts, except high tensile bolts, shall conform to the specifications for Steel Machine Bolts and Nuts and Tap Bolts, A.S.T.M. Designation: A 307, Grade A.

When high tensile bolts are required, such bolts shall conform to the specifications for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers, A.S.T.M. Designation: A 325.

All bolt holes shall be truly cylindrical. The size of holes shall be $\frac{1}{16}$ inch greater than the nominal diameter of the bolts and shall make a driving fit with the bolts. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

The heads and nuts shall be drawn tight against the work with a suitable wrench not less than 15 inches long. Bolt heads shall be tapped with a hammer while the nut is being tightened. Where bolts are to be used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut. Ribbed bolts shall be furnished in the same number and in nominal sizes not smaller than the rivets for which they are substituted. They shall be furnished in sufficient variety of lengths that when drawn tight the fluted shank will fill the hole in the work and the thread will completely fill the nut with not more than one thread protruding. All bolts shall have cut threads neatly and accurately finished.

If for any reason the bolts twist before drawing tight, the hole shall be carefully reamed and the bolt replaced with a new bolt of a diameter to fit properly in the hole.

The contractor shall provide and supply himself with oversize bolts for this replacement in an amount not less than 10 per cent of the number of ribbed bolts specified.

The nuts of unfinished, turned bolts and ribbed bolts shall be effectually locked after they have been finally tightened.

2. Unfinished Bolts: Unfinished bolts shall be standard bolts with hexagonal heads and nuts except that bolts used in handrail connections shall have button heads and hexagonal nuts. The diameter of the bolt holes shall be $\frac{1}{16}$ inch greater than the diameter of the bolts used. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of such length that they will extend entirely through their nuts, but not more than $\frac{1}{4}$ inch beyond them. The number of bolts furnished shall be 5 per cent more than the actual number shown on the plans for each size and length.

Each unfinished bolt shall be provided with one nut and one S.A.E. standard lock washer, unless the bolt is used in connections provided with holes slotted or enlarged to allow for expansion and contraction, in which case the bolt shall be provided with 2 nuts so that the nuts may be locked without drawing up the parts too tight to prevent movement, and cut washers shall be furnished if the slotted or enlarged holes so require.

3. Turned Bolts: Holes for turned bolts shall be carefully reamed and the bolts turned to a driving fit with the threads entirely outside of the holes and one S.A.E. heavy lock washer shall be used. The heads and nuts shall be hexagonal.

One-fourth inch nut locks shall be used on all turned bolts unless otherwise specified on the plans. Turned bolts shall be finished by a finishing cut.

4. Special Ribbed Bolts: Ribbed bolts, with drive fit, shall be used only where called for on the plans. Ribbed bolts may be substituted for field rivets in locations where, in the opinion of the engineer, it is impractical to drive rivets. Ribbed bolts shall be of an approved type and shall have button heads and hexagonal nuts.

If, for any reason, the ribbed bolt should twist before drawing tight, the hole shall be carefully reamed and the bolt replaced with a new bolt of a diameter to fit properly in the enlarged hole.

Each ribbed bolt shall be provided with one nut and one S.A.E. heavy lock washer, unless the bolt has self-locking threads or the nuts are self-locking. If the ribbed

bolt has self-locking threads or if the nuts are self-locking, plain cut washers not less than ¼ inch thick, or S.A.E. heavy lock washers shall be used under all nuts, unless the nuts are recessed. If the ribbed bolt has self-locking threads, or if the nuts are self-locking, no washers of any kind shall be required if the nuts are recessed so they can be drawn tight even though the length of the ribbed section is greater than the thickness of the work.

5. High Tensile Bolts: High tensile bolts, nuts and washers shall conform to the following requirements:

(1) General:

This specification covers the assembly of structural connections using high-tensile-strength bolts and nuts with hardened washers where the initial tension in the bolt produces friction on the contact surfaces of the connected pieces sufficient in magnitude to resist shear.

High-tensile-strength bolts may be substituted for rivets as indicated by the plans or special provisions.

Except as otherwise provided herein, construction shall conform to applicable specifications for riveted structures.

Bolts, nuts, and washers shall conform to the requirements of the Specifications for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers, A.S.T.M. Designation: A 325. Bolts manufactured to this specification are identified by marking on the top of the head with 3 radial lines.

Bolt dimensions shall conform to the current requirements for regular semifinished hexagon bolts, A.S.A. Designation: B 18.2.

Nut dimensions shall conform to the current requirements for heavy semifinished hexagon nuts, A.S.A. Designation: B 18.2.

Washer dimensions shall not be less than would conform to the current requirements of A.S.A. Designation: B 27.2.

(2) Dimensions of Bolts, Nuts and Washers:

Bolt lengths shall be determined by adding the values given in Table I to the total thickness of connected

material. The values in Table I compensate for thickness of nut, 2 flat washers, and bolt point. The total length shall be adjusted to the next ¼-inch increment up to 5-inch length and to the next longer ½-inch increment for lengths over 5 inches.

TABLE I—BOLT LENGTHS

Bolt Size (In.)	Add to Grip (In.)
½	1
⅝	1⅛
¾	1¼
⅞	1½
1	1⅝
1⅛	1¾
1¼	1⅞

If other than the standard thickness of circular washer as given in Table II is used, the necessary bolt length shall be adjusted accordingly. Where beveled washers of the dimensions given in Table II are used, an additional ⅛-inch shall be added for each such beveled washer.

TABLE II—WASHER DIMENSIONS

Bolt Size (In.)	Circular Washers			Square Beveled Washers for American Standard Beams and Channels		
	Inside Diameter (In.)	Outside Diameter (In.)	Thickness Gage No.	Width (In.)	Mean Thickness (In.)	Slope
½.....	9/16	1⅜	12	1¾	5/16	1:6
⅝.....	11/16	1¾	10	1¾	5/16	1:6
¾.....	13/16	2	9	1¾	5/16	1:6
⅞.....	15/16	2¼	8	1¾	5/16	1:6
1.....	1 1/16	2½	8	1¾	5/16	1:6
1⅛.....	1¼	2¾	8	2¼	5/16	1:6
1¼.....	1⅜	3	8	2¼	5/16	1:6

Circular washers shall be flat and smooth and their dimensions shall be not less than would conform to the current requirements of A.S.A. Designation: B 27.2 as given in Table II. Where clearance is necessary, washers may be clipped on one side to a point not closer than ⅞ of the bolt diameter from the center of the washer. Where bearing faces of the bolted parts have a slope of more than 1:20 with respect to a plane normal to the bolt axis, smooth beveled washers shall be used to compensate for lack of parallelism.

Nut dimensions shall conform to the current requirements for heavy semifinished hexagon nuts, A.S.A. Designation: B 18.2.

(3) Bolted Parts and Assembly:

Holes may be punched, subpunched and reamed or drilled, as required by the applicable specification for riveted construction, and shall be of a diameter not more than 1/16-inch in excess of the nominal bolt diameter.

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts.

Contact surfaces of joints shall be free of paint or lacquer unless otherwise indicated by the plans or special provisions.

Connections shall be assembled with a hardened washer under the bolt head and nut. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel, except flat washers may be used on surfaces having a slope not greater than 1:20 with respect to a plane normal to the bolt axis, provided the nut is torqued against a non-sloping surface. For slopes greater than 1:20, smooth beveled washers shall be used to produce parallelism.

All nuts shall be tightened to give at least the required minimum bolt tension values given in Table III upon completion of the joint.

TABLE III—BOLT TENSION AND TORQUE VALUES

Bolt Size (In.)	Recommended* Bolt Tension For Calibrating Wrenches (Lb.)	Required† Minimum Bolt Tension (Lb.)	Approximate‡ Equivalent Torque For Required Minimum Bolt Tension (Lb. Ft.)
½	12,500	10,850	90
⅝	20,000	17,250	180
¾	29,000	25,600	320
⅞	37,000	32,400	470
1	49,000	42,500	710
1⅛	58,000	50,800	960
1¼	74,000	64,500	1,350

*Approximately 15 per cent in excess of the Required Minimum Bolt Tension.

†Equal to 90 per cent of the minimum Proof Load of Bolt (A. S. T. M. A 325). There is no recommended maximum bolt tension.

‡Equal to 0.0167 lb. ft. per in. bolt diameter per lb. tension for nonlubricated bolts and nuts. Values given are experimental approximations. If torque rather than tension is to be measured, the torque-tension ratio shall be determined by the actual conditions of the application.

Note 1—Wrenches should be set to induce a bolt tension in excess of the Required Minimum Bolt Tension as given in Table III. Because of the varying relation between torque and induced tension, it is suggested that wrenches be set to induce the Recommended Bolt Tension for Calibrating Wrenches as given in Table III.

Note 2—In using a power wrench, the recommendations of the wrench manufacturer should be consulted in its operation and care should be taken that the machine is maintained in proper working condition and proper calibration.

Note 3—In using a manual torque wrench, the required torque can be read from the wrench dial, or in other types of wrenches, the torque may be indicated by a release of the wrench. Care should be taken that the wrench is properly calibrated. Nuts shall be in motion when torque is measured.

Note 4—In using manual plain wrenches, a ratchet wrench of length consistent with the man-effort available should be used so that the product of the effective wrench length in feet times the man-effort in pounds exceeds the equivalent torque required.

(4) Inspection:

The inspector shall satisfy himself that all requirements of this specification are met. The inspector shall approve the procedure for calibration of wrenches and installation of bolts. The inspector shall further observe the field installation to determine that these procedures are followed. No further inspection is normally required. Where further inspection is required by the engineer, he shall specify in advance the method the inspector is to follow.

(s) Riveting: 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, in the opinion of the engineer, 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, in the opinion of the engineer, the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over ⅝ inch.

(t) Edge Planing: Sheared edges of plates more than ⅝ inch in thickness and carrying calculated stress shall be planed to a depth of ¼ inch. Re-entrant cuts shall be filleted before cutting.

(u) Welds: Welding of steel structures, when authorized, shall conform to the Specifications for Welded Highway and Railway Bridges of the American Welding Society.

If a fabricating shop prequalifies its metal-arc welding operators according to the standard qualification procedure of the American Welding Society and certifies to the engineer that an operator working on the structure has been prequalified within 12 months previous to the beginning of work on the subject structure, the engineer may consider such operator qualified. The certificate shall state that such operator shall have been doing satisfactory welding of the required type within the 3 month period previous to the subject work. A certification shall be submitted for each operator and for each project, stating the name of the operator, the name and title of the person who conducted the examination, the kind of specimens, the positions of welds, the results of the tests and the date of the examination. Such a certification of prequalification may also be accepted as proof that an operator on field welding is qualified, if the contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

(v) Flame Cutting: Steel or wrought iron may be flame cut, provided a smooth surface is secured by the use of a mechanical guide. Flame cutting by hand shall be done only where approved by the engineer and the surface shall be made smooth by planing, chipping or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than ½ inch.

In the case of silicon steel, flame cut edges shall be removed to a depth of at least ¼ inch, by milling, chipping or grinding, except that machine flame cut edges may be used without such removal if the edges are softened after cutting; (a), by heating the cut edge uniformly and progressively to a red heat, visible in ordinary shop light (1150° to 1250°F) to a depth of at least 1/16 inch; or (b), by means of a post-heating torch attached to and following the cutting torch; the tips, gas pressure, speed of travel and the distance of post-heating torch from kerf regulated to the thickness of the steel. Bend test specimens so cut and flame softened shall meet the bend test re-

quirements for that thickness in the Specifications for Structural Silicon Steel, A.S.T.M. Designation: A 94.

(w) Facing of Bearing Surfaces: The top and bottom surfaces of steel slabs and base plates, and cap plates of columns and pedestals, shall be planed, or else the plates or slabs hot straightened. Parts of members in contact with them shall be faced.

Sole plates of beams and girders shall have full contact with the flanges. Sole plates and masonry plates shall be planed or hot straightened. Cast pedestals shall be planed on surfaces to be in contact with steel and shall have the surface to be in contact with masonry, rough-finished.

Surfaces of bronze bearing plates intended for sliding contact shall be finished.

In planing the surfaces of expansion bearings the cut of the tool shall be in the direction of expansion.

(x) 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.

(y) End Connection Angles: Floor beams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than that shown on the detail drawings.

(z) Lacing Bars: The ends of lacing bars shall be neatly rounded unless another form is required.

(aa) Finished Members: Finished members shall be true to line and free from twists, bends and open joints.

(bb) Web Plates: In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than ⅛ inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be ½ inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed ⅜ inch. The clearance

at the top and bottom ends of the web splice plates shall not exceed ¼ inch.

(cc) Bent Plates: Cold-bent load-carrying rolled-steel plates shall conform to the following:

1. They shall be so taken from the stock plates that the bend-line will be at right angles to the direction of rolling.

2. The radius of bends, measured to the concave face of the metal, shall not be less and preferably shall be greater than shown in the following table, in which "T" is the thickness of the plate:

Angle through which plate is bent	Minimum Radius
61 degrees to 90 degrees	1.0T
91 degrees to 120 degrees	1.5T
121 degrees to 150 degrees	2.0T

If a shorter radius is essential, the plates shall be bent hot. Hot-bent plates shall conform to requirement (1) above.

3. Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout that portion of the plate at which the bending is to occur.

(dd) Fit of Stiffeners: End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within ¼ inch at each end.

Welding will be permitted in lieu of milling or grinding if noted on the plans or specified in the special provisions. Welding transversely across the tension flanges of beams or girders, which have a flange stress of more than 75 per cent of their designed capacity, will not be permitted.

(ee) Eyebars: Eyebars shall be straight, true to size, and free from twists, folds in the neck and head, and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eyebars are made, if they are satisfactory to the engineer. The thickness of the head and neck shall not overrun more than 1/16 inch.

Eyebars that are to be placed side by side in the structure shall be bored so accurately that, upon being placed together, pins 1/32 inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

(ff) Annealing: Before boring, eyebars shall be annealed to produce the required physical qualities and shall be straightened. Proper instruments shall be provided for determining at any time the temperature of the bars.

Other steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Crimped stiffeners need not be annealed.

(gg) Pins and Rollers: Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws.

Pins and rollers more than 7 inches in diameter shall be forged and annealed.

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.

(hh) 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 holes in tension members and inside to inside of 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 riveting is completed.

(ii) Pin Clearances: The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or 1/32 inch for larger pins.

(jj) Screw Threads: Threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that the pin ends having a diameter of 1 3/8 inches or more shall be threaded 6 threads to the inch.

(kk) Pilot and Driving Nuts: Two pilot nuts and 2 driving nuts for each size of pin shall be furnished, unless otherwise specified.

(ll) Camber for Rolled Beams in Simple Spans: When required on the plans, beams shall be cambered so that the beams will 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 inch under.

Beams may be cambered cold or may be heated. If heat is used, the bottom, or tension, flange shall be heated uniformly and progressively to not more than a red heat visible in ordinary shop light (1150° to 1250°F) while the beam is loaded to produce compression in the bottom flange. 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.

7.15 Mill and Shop Inspection:

The contractor shall give the engineer ample 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 the engineer has been so notified. The contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the works.

The inspector shall have the authority to reject any material or work which does not meet the requirements of these specifications.

The contractor shall furnish the engineer with duplicate copies of mill orders or as the engineer may direct.

The contractor shall furnish test specimens, as specified herein, without extra charge; also the labor, testing machines and tools necessary to make the specimen tests.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective.

7.16 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 the engineer 2 copies of material orders, and 3 copies of shipping statements and erection diagrams, or 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.

7.17 Painting:

Shop and field paints and their application shall comply with the applicable requirements under "Painting," Section 4, Part 5, Division II.

7.18 Erection of Structural Steel:

All structural steel shall be erected in accordance with the requirements of these specifications and the specifications for this class of work under "Steel Bridges," Section 2, Part 4, Division II.

7.19 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.

7.20 Setting Bench Mark Plates:

A bench mark plate furnished and delivered by the engineer shall be set by the contractor without extra compensation on each bridge. 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 by the engineer will be permitted on any structure.

7.21 Cleaning-up:

Upon completion and before final acceptance, the contractor shall remove all equipment, falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the contractor before final acceptance.

MEASUREMENT AND PAYMENT

7.22 Method of Measurement:

General: All structural steel will be measured by the weight of metal in pounds remaining in the completed and accepted structures, and the weight shall be computed on the basis of theoretical net weight from the approved shop detail drawings. No allowance will be made for excess field rivets, and no deductions will be made for rivet holes, bolt holes, beam copings or cut flanges. Deduction will be made for pin holes. All plates shall be estimated from the

size billed and deductions made for cut corners. The weight of heads only of all rivets shall be included in the computed weight.

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; bolts connecting structural members to other structural members, or to concrete; anchor bolts, including those for roadway gates; and bronze and cast iron for expansion plates will be classified and measured as structural steel.

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.

No allowance will be made for over-run on plates or rolled sections.

When full-sized tests 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.

Fabricated Carbon Steel: Fabricated carbon steel shall include all steel classified as such on the contract drawings, and unless otherwise noted on the plans, such minor items as rivet heads, anchor materials including bolts, pins, rollers, metal railings, heads and nuts of permanent bolts connecting steel to steel, 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 items described under "General," necessary to complete this portion of the structure.

The weight of rivet heads shall be as given in the following table:

WEIGHT OF HIGH BUTTON (ACORN) HEADS AFTER DRIVING

Diameter of Rivet, Inches.....	½	⅝	¾	⅞	1	1⅛	1¼
Weight per 100 Heads, Lbs.....	4	7	12	18	26	36	48

The weight of bolt heads and nuts shall be as given in the table on the following page.

Bridge hardware connectors for joining timber members, nails, spikes, and bolts (except as provided above) shall not be included in the poundage, or paid for.

Fabricated Silicon Steel: Fabricated silicon steel shall include all steel classified as such on the contract drawings. No incidentals will be measured as fabricated silicon steel.

Structural Low-Alloy Steel: Structural low-alloy steel shall include all steel classified as such on the contract drawings.

Structural Nickel Steel: Structural nickel steel shall include all steel classified as such on the contract drawings.

Structural Welding Steel: Structural welding steel shall include all steel classified as such on the contract drawings.

7.23 Basis of Payment:

The number of pounds of completed and accepted steel and other metals of the various categories, measured as provided above, shall be paid for at the contract unit price per pound for "Fabricated Carbon Steel," "Fabricated Silicon Steel," "Structural Low-Alloy Steel," "Structural Nickel Steel," or "Structural Welding Steel," as the case may be, which price and payment shall constitute full compensation for furnishing, fabricating, delivering, erecting, and painting all the steel and other metal and for all labor, equipment, tools and incidentals necessary to complete the item.

Asphaltic concrete filling for recesses in structural steel members, if required, shall be included in the unit prices for the various items of structural steel.

The expense of conducting "full-size tests," if required, shall be borne by the contractor.

WEIGHT OF BOLT HEADS AND NUTS IN POUNDS PER 100

Weight of 100 Each		Diameter of Bolt, Inches										
		¼	5/16	⅜	7/16	½	⅝	¾	⅞	1	1⅛	1¼
Regular	Square Heads	.7	1.4	2.2	3.2	5.1	10	18	29	42	60	84
	Hexagon Heads	.6	1.2	1.9	2.8	4.5	9	15	25	36	52	73
	Square Nuts	.81	1.7	2.3	4.1	5.6	10	14	23	35	49	67
	Hexagon Nuts	.64	1.4	1.9	3.7	4.2	9	12	18	28	42	54
Heavy	Square Heads					9.5	17	28	42	61	84	112
	Hexagon Heads					8.2	14	24	36	53	73	94
	Square Nuts					7.9	14	23	35	50	66	92
	Hexagon Nuts					6.6	11	19	28	41	56	73

HEAVY BOLTS

Weights of bolts over 1¼ inches in diameter may be calculated from the following data. Standard practice is "American Standard Regular" head with "American Standard Regular" or "Heavy" nut, as specified.

Weight of 100 Each		Diameter of Bolt, Inches										
		1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
Regular	Square Heads	143	226	343	484	660	881	1148	1452	1830	2241	2710
	Hexagon Heads	124	196	297	419	577	764	994	1257	1585	1941	2350
	Square Nuts	116	184	276	391	539	666	874				
	Hexagon Nuts	102	162	231	337	472	606	825				
Heavy	Square Heads	190	295	432	608	825	1087	1401	1775	2115	2715	3312
	Hexagon Heads	162	254	377	538	727	890	1214	1526	1906	2344	2845
	Square Nuts	154	242	355	496	674	831	1082	1767	2043	2303	2969
	Hexagon Nuts	123	208	303	422	573	742	1008	1196	1485	1789	2184
Pounds per linear in. of Shank		.5007	.6815	.8900	1.127	1.391	1.683	2.003	2.348	2.723	3.126	3.556

When the contract price of fabricated carbon steel, fabricated silicon steel, structural low-alloy steel, structural nickel steel, or structural welding steel or of the combination of these items exceeds $10,000.00, the number of pounds of the various items to be allowed by the engineer on the monthly estimates shall be as follows:

Sixty per cent of the number of pounds of the various items of structural steel delivered and properly stored at the bridge site.

Seventy-five per cent of the number of pounds of the various items of structural steel erected in place and bolted.

Ninety per cent of the number of pounds of the various items of structural steel erected in place and riveted.

One hundred per cent of the number of pounds of the various items of structural steel erected complete in place and painted.

Payment will be made under:

Item 4-7-1, Fabricated Carbon Steel, per pound.
Item 4-7-2, Fabricated Silicon Steel, per pound.
Item 4-7-3, Structural Low-Alloy Steel, per pound.
Item 4-7-4, Structural Nickel Steel, per pound.
Item 4-7-5, Structural Welding Steel, per pound.

SECTION 8

UNTREATED AND TREATED TIMBER

8.01 Description:

This item shall consist 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 as called for in the contract, and of preparing, framing, assembling and erecting the same, including painting where specified, and including also all hardware required by the plans and specifications, all in accordance with these specifications and in conformity with the structure design and details as shown on the plans or directed by the engineer.

MATERIALS

8.02 General:

(a) Treated Timber: Treated timber shall be interpreted to mean timber of the species and stress-grade called

for, treated as stipulated in "Preservative Treatments for Timber," Section 3, Part 5, Division II. The various types of preservatives permitted for use, and the portions of structures where the several types may be used shall be as provided on the plans or in the special provisions.

(b) Surfacing: All lumber and timber, except bulkhead planks and sway bracing shall be surfaced on 4 sides (S4S) unless otherwise called for on the plans.

8.03 Species of Woods:

The common and botanical names of the species of woods recognized in these specifications are described as follows:

Common Names	Botanical Names
Douglas Fir (Coast)	Pseudotsuga taxifolia (Coast)
Southern Pine includes:	
Loblolly Pine	Pinus taeda
Longleaf Pine	Pinus palustris
Pitch Pine	Pinus rigida
Pond Pine	Pinus serotina
Shortleaf Pine	Pinus echinata
Slash Pine	Pinus caribaea

8.04 Species to Be Used:

(a) Permanent Structures: Unless otherwise shown on the plans or provided in the special provisions, all lumber and timber used in the construction of permanent bridges, bridge fenders, bulkheads, culverts, and timber cattle guards may be either Douglas Fir or Southern Pine, as the contractor elects, however, 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 structue shall be the same species.

Lumber and timber shall not be used in exposed structures without preservative treatment unless otherwise indicated on the plans or in the special provisions. Treated timber shall conform to Article 8.02 (a).

(b) Temporary Structures: Temporary structures may be any species and grade of timber which is satisfactory for the intended purpose. Temporary structures furnished for detours shall be constructed of sufficient strength to withstand legal load limits at all times during their use.

8.05 Grading:

(a) Grading of Yard Lumber: Yard lumber shall be graded in accordance with grading rules, adopted by regional associations of lumber manufacturers, which conform to the basic provisions of the "American Lumber Standards."

Lumber ordered in multiple lengths shall be graded after being cut to length.

(b) Grading of Structural Timber: Structural timber used as a permanent part of a structure shall be graded, for the grade selected, in accordance with the grading rules adopted by the regional association of the lumber manufacturers which conform to the basic provisions of the "American Lumber Standards." The grade to be used shall be as specified in the special provisions or as shown on the plans.

The special provisions referring to commercial grading rules shall contain the following:

(1) The name of the association.
(2) The year of issue of the grading rules referred to.
(3) The paragraph number.
(4) The stress grade selected.
(5) The species.
(6) Square edge, if wane is not permitted.
(7) Any heartwood requirements.

The material supplied according to the commercial grading rules shall be of equal or greater stress value than the stress grade specified.

8.06 Timber Connectors:

Connectors for treated timber structures, except those of malleable iron, shall be galvanized in accordance with

the requirements of the Specifications for Zinc (Hot-Galvanized) Coatings on Structural Steel Shapes, Plates and Bars, and Their Products, A.S.T.M. Designation: A 123, and shall be one of the following types as specified on the plans:

(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 the Specifications for Carbon-Steel Blooms, Billets, and Slabs for Forgings, A.S.T.M. Designation: A 273, Grade No. 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:

For 2½-inch split-rings—inside diameter, 2.56 inches; width of groove, 0.18 inch; depth of groove, 0.37 inch.

For 4-inch split-rings—inside diameter, 4.08 inches; width of groove, 0.21 inch; depth of groove, 0.50 inch.

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 U. S. Standard 16-gage hot rolled sheet steel conforming to the Specifications for Carbon-Steel Blooms, Billets, and Slabs for Forgings, A.S.T.M. Designation: A 273, Grade No. 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; 2-inch, 2⅝-inch, 3⅜-inch and 4-inch diameters; shall have an over-all depth of 0.94 inch and a 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 mild steel conforming to the Specifications for Carbon-Steel Blooms, Billets, and Slabs for Forgings, A.S.T.M. Designation: A 273, Grade No. 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 the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47, Grade No. 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 the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47, Grade No. 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 the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47, Grade No. 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.

8.07 Hardware, Structural Shapes, etc.:

Hardware, structural shapes, etc., shall conform to the requirements of Articles 3.03 and 3.04, Part 4, Division II.

8.08 Paint:

All paint materials shall comply with the applicable requirements under "Painting," Section 4, Part 5, Division II.

CONSTRUCTION METHODS

8.09 General:

In addition to the applicable requirements under construction methods of "Timber Bridges," Section 3, Part 4, Division II, the following specific requirements shall be adhered to in the construction of untreated and treated timber structures.

8.10 Storage:

Lumber and timber on the site of the work shall be stored in orderly piles or stacks. Untreated material shall be open-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When required by the engineer, it shall be protected from the weather by suitable covering. Creosoted timber and piling shall be close-stacked piled to prevent warping, and the tops of the stacks shall be covered. The ground underneath and in the vicinity of all material piles shall be cleared of weeds and rubbish.

8.11 Placing Timber Connectors:

Timber connectors, when required, shall be one of the types contained in Article 8.06, as specified on the plans.

The split ring and the shear plate shall be installed in precut grooves of dimensions as specified 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. The claw plate shall be installed by a combination of both methods, partially by precut grooving and partially by pressure.

Fabrication of all connectored structures shall be done prior to treatment. When fabricated from templets or shop details, bolt holes shall not be more than $\frac{1}{16}$ inch from required placement. Bolt holes shall be $\frac{1}{16}$ inch larger than the diameter of the bolts. Bolt holes 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.

8.12 Handling:

The timber shall be handled carefully without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, peaveys, hooks or pike-poles shall not be used.

8.13 Framing and Boring:

All cutting, framing and boring of treated timbers shall be done before treatment insofar as is practicable. When treated timbers are to be placed in waters infested by marine borers, cutting and boring below high water elevation shall be avoided.

8.14 Cuts and Abrasions:

All cuts in treated timbers, and all abrasions after having been carefully trimmed, shall be covered with 2 applications of a mixture of 60 per cent creosote oil and 40 per cent roofing pitch or brush coated with at least 2 applications of hot creosote oil and covered with hot roofing pitch.

8.15 Treating Bolt Holes:

Before driving bolts, all holes bored after treatment shall be impregnated with hot creosote oil by means of an approved pressure bolt hole treater. Any unfilled holes, after being treated with creosote oil shall be plugged with creosoted plugs.

8.16 Untreated Timber:

In structures of untreated timber, the following surfaces shall be coated thoroughly with 2 coats of hot creosote oil before assembling: Ends, tops and all contact surfaces of posts, sills, caps, floor beams and stringers, and all ends, joints and contact surfaces of bracing. Timber bumpers, the back faces of bulkheads and all other timber which is to be in contact with earth shall be similarly treated.

8.17 Painting:

Painting, where required by the plans, shall conform to the applicable requirements under "Painting," Section 4, Part 5, Division II.

MEASUREMENT AND PAYMENT

8.18 Method of Measurement:

The quantity to be paid for shall be the number of thousand feet board measure of lumber and timber, complete in place and accepted. Measurements of lumber and timber will be computed from the net dimensions shown on the plans, unless changes in such dimensions have been authorized in writing by the engineer. The dimensions shown on the plans shall be interpreted as nominal sizes and shall be used in the computations. The measurement of timber will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, bracing, sheeting, etc.

No measurement will be made for hardware required to construct the work in accordance with the plans.

8.19 Basis of Payment:

The quantities measured as provided above, shall be paid for at the contract unit price per thousand feet board measure for "Untreated Timber," or "Treated Timber," as the case may be, which price and payment shall be full compensation for furnishing and delivering all timber, lumber and hardware, including any preservative treatment required, for preparing, framing, assembling, erecting and painting, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Item 4-8-1, Untreated Timber, per thousand feet board measure.

Item 4-8-2, Treated Timber, per thousand feet board measure.

SECTION 9

CULVERT PIPE
SEWER PIPE
STRUCTURAL PLATE PIPE-ARCHES

9.01 Description:

This item shall consist of furnishing sections of concrete, corrugated metal, cast iron, or vitrified clay pipe, or of structural plate pipe-arch, of the dimensions shown on

the plans, and installing such pipe at the locations indicated on the plans, or ordered by the engineer, in conformity with the lines and grades given.

When the term "Culvert Pipe" is shown on the plans or in the proposal, it shall be interpreted to mean either reinforced concrete culvert pipe (standard strength) or corrugated metal pipe culvert (asphalt coated), as the contractor elects, of the dimensions shown on the plans.

MATERIALS

9.02 Reinforced Concrete Pipe:

These specifications cover reinforced concrete pipe for use in the construction of pipe culverts and pipe storm sewers. Unless otherwise specified on the plans or in the proposal, standard strength pipe shall be furnished.

All reinforced concrete pipe furnished shall conform to the requirements of the Specifications for Reinforced Concrete Culvert Pipe, A.A.S.H.O. Designation: M 41, with the following exceptions:

(a) Cement: Portland cement shall conform to the requirements of Article 5.03, Part 4, Division II. High Early Strength Portland cement shall conform to the requirements of Article 5.04, Part 4, Division II.

(b) Water: Water for use with cement shall conform to the requirements of Article 5.05, Part 4, Division II.

(c) Steel: Reinforcement shall be either bar reinforcement or wire conforming to the respective requirements of Articles 6.02 and 6.03, Part 4, Division II.

(d) Aggregates: Sand shall be composed of clean, hard, durable, uncoated grains, free from lumps of clay, soft or flaky particles, salt, alkali, loam, organic or other objectionable matter.

The coarse aggregate shall consist of clean, hard, tough and durable stone fragments, free from dust, dirt, thin or elongated pieces or other objectionable matter.

(e) Mixture: The aggregates shall be so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of these specifications.

9.03 Corrugated Metal Pipe Culverts:

These specifications cover corrugated metal pipe for use in the construction of pipe culverts. Corrugated metal pipe shall conform to the requirements of the Specifications for Corrugated Metal Pipe Culvert, A.A.S.H.O. Designation: M 36.

9.04 Corrugated Metal Pipe-Arch Culverts:

These specifications cover corrugated metal pipe-arches for use in the construction of pipe culverts. Corrugated metal pipe-arches shall consist of corrugated metal pipes which have been reformed to multi-centered pipes having arch shape tops with a slightly outwardly curved integral bottom. They shall be fabricated from standard length culvert sheets and factory riveted to form a continuous pipe-arch. When the length of the pipe-arch required for a complete structure is longer than can be conveniently handled in one piece, band couplers shall be used to make the field connections.

The requirements for base metal, spelter coating, rivets, sampling, testing, brands, corrugations, end finish, bands, and workmanship shall conform to the applicable sections of the Specifications for Corrugated Metal Pipe Culvert, A.A.S.H.O. Designation: M 36.

Dimensions, tolerances, areas, weights and gages shall be in accordance with the following table:

Span In.	Rise In.	Gage Pipe	Area Sq. Ft.	"T" In.	"B" In.	Gage Bands
18.....	11	16	1.1	6½	4½	16
22.....	13	16	1.6	8¼	4¾	16
25.....	16	16	2.2	10¾	5¼	16
29.....	18	14	2.8	12½	5½	16
36.....	22	14	4.4	15¾	6¼	16
43.....	27	12	6.4	20	7	14
50.....	31	12	8.7	23	8	14
58.....	36	12	11.4	26¾	9¼	14
65.....	40	12	14.3	29½	10½	14
72.....	44	10	17.6	32¼	11¾	12

All dimensions are measured from the inside crests of the corrugations. A tolerance of plus or minus one inch will be permissible in span, rise, "T" and "B". The dimensions "T" and "B" shall be measured vertically from a horizontal line drawn across the widest portion of the arch. The dimension "T" is the distance from this horizontal line to the highest point of the intrados of the arch. The dimension "B" is the distance from this horizontal line to the lowest portion of the base. The minimum radius of curvature of any part of the pipe-arch section shall be 3 inches.

The lapped longitudinal seams shall be factory riveted and shall be staggered so as to alternate on each side of the center of the top of the arch by approximately 15 per cent of the periphery.

9.05 Metal End Sections:

These specifications cover metal end sections to be attached to the inlet and outlet ends of corrugated metal pipe and pipe-arch culverts.

Metal end sections shall meet the requirements of the Specifications for Corrugated Metal Culvert Pipe, A.A.S.H.O. Designation: M 36 for base metal, spelter coating, rivets, riveting, sampling, accepted brands of metal, sheet manufacturer's certified analysis, sheet manufacturer's guarantee, and gage determination and tolerance.

Units fabricated under these specifications shall be made to conform to the shape and dimensions as shown on the plans. They shall be manufactured as integral units or so that they can be readily assembled and erected in place.

Galvanized bolts shall be used for assembly of end sections where more than one piece is used to form the skirt.

It is the essence of these specifications that in addition to compliance with the details of construction, the completed unit shall show careful, finished workmanship in all particulars. The following defects are specified as constituting poor workmanship and the presence of any of them in any individual unit in any shipment shall constitute sufficient cause for rejection.

Not meeting specified dimensions.
Not of specified shape.
Uneven laps.
Ragged sheared edges.
Loose unevenly lined or spaced rivets.

Poorly formed rivet heads.
Illegible brands.
Lack of rigidity.
Dents or bends in the metal itself.

9.06 Asphalt Coating of Corrugated Metal Pipe Culverts, Corrugated Metal Pipe-Arch Culverts and Metal End Sections:

These specifications cover asphalt coating of corrugated metal pipe and pipe-arch and metal end sections. The metal shall be completely and uniformly coated on all sides with an asphalt cement as herein specified to a minimum thickness of 0.03 inch, measured on the crests of the corrugations of pipe and pipe-arch and on the surface of the end sections.

The asphalt cement shall adhere to the metal tenaciously, shall not chip off in handling, and shall protect the pipe from deterioration as evidenced by meeting the following performance requirement tests:

(a) Solubility Test: The asphalt cement shall be 99.5 per cent soluble in carbon disulphide.

(b) Stability Test: Parallel lines shall be drawn along the valleys of the corrugations of a representative sample of coated pipe and the specimen placed on end in a constant temperature oven, with the parallel lines in a horizontal position. The temperature of the specimen shall be maintained within 2° of 150°F for a period of 4 hours. At the end of this time no part of any line shall have dropped more than ¼ inch.

(c) Imperviousness Test: A 25 per cent solution of sulphuric acid, or a 25 per cent solution of sodium hydroxide, or a saturated salt solution (such as sodium chloride) shall be held in the valley of a corrugation for a period of 48 hours, during which time no loosening or separation of the bituminous material from the galvanizing shall have taken place.

(d) Erosion Test: A representative sample consisting of a 2-foot length of a full coated pipe (with ends closed by suitable bulkheads) shall be revolved end over end about its transverse axis at a speed of 3.7 revolutions per minute and in such a manner that the erosive charge shall alternately roll along the inner surface of opposite sides of the pipe. At least 75 per cent of the sample shall be immersed,

as it revolves, in a bath of water maintained at a temperature of 50° to 55°F. The pipe shall not show areas of bare metal more than 2 inches in length on 4 of the 7 central corrugations after 5 hours of continuous testing. The erosive charge shall be 50 pounds of grade MW building brick, conforming to the requirements of the Specifications for Building Brick, A.S.T.M. Designation: C 62, broken up into pieces 2 to 3 inches in diameter, and 3 gallons of water.

9.07 Structural Plate Pipe-Arches:

These specifications cover structural plate pipe-arch intended for use for the construction of culverts.

Plates shall be fabricated from base metal made by the open hearth method and conforming to one of the chemical requirements contained in Table I of the Specifications for Corrugated Metal Culvert Pipe, A.A.S.H.O. Designation: M 36. Plates shall otherwise comply with the following requirements:

(a) Spelter Coating: A coating of prime western spelter or equal shall be applied by the hot-dip process at a rate of not less than 2.0 ounces per square foot of double-exposed surface. If the average spelter coating as determined from the required samples is less than 2.0 ounces, or if any one specimen shows less than 1.8 ounces, the lot sampled shall be rejected. The spelter coating shall be of first class commercial quality, free from injurious defects, such as blisters, flux and uncoated spots.

(b) Galvanizing: The corrugated plates may be fabricated from galvanized sheets or plates and no further galvanizing will be required after fabrication if the spelter coating has not been injured in the fabrication process.

(c) Sampling: For testing the weight of spelter coating and for chemical analysis, when required, a sample shall be provided for each 100 plates of a shipment or fraction thereof. A coupon approximately 3 inches square shall be cut from the corner of a plate or a coupon approximately 6 inches square of the same gage and base metal as the material samples shall be attached to the center of one edge prior to galvanizing. If the result of a weight of coating test for any coupon does not conform to the requirements specified, retests of 2 additional samples cut from the product plates for the order shall be made, each of which shall conform to the requirements specified.

(d) Chemical Analysis and Test for Spelter Coating: When required, the chemical analysis of base metal shall be made in accordance with the Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron, A.S.T.M. Designation: E 30.

The test for weight of spelter coating shall be made in accordance with the Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, A.S.T.M. Designation: A 90.

(e) Certified Analysis and Guarantee: The manufacturer of the base metal shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of carbon, manganese, phosphorus, sulphur, silicon and copper; also molybdenum, when provided for under the particular kind of base metal. The certificate shall be sworn to for the manufacturer by a person having legal authority to bind the company.

The manufacturer shall include in the certificate a guarantee providing that all metal furnished shall conform to the specification requirements, shall bear a suitable identification brand or mark, and shall be replaced without cost when not in conformity with the specified analysis, gage, or spelter coating, the cost to be limited to the replacement of structural plate material only; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

One brand only shall be approved for each kind of base metal furnished by each of the actual manufacturers of the base metal.

(f) Identification: No plates will be accepted unless the metal is identified by a stamp on each plate showing:

1. Name of base metal manufacturer.
2. Name of brand and kind of base metal.
3. Gage number.
4. Weight of spelter coating.
5. Identification symbols showing heat number.

The identification brands shall be so placed that when the pipe-arch is erected the identification will appear on the inside of the structure.

(g) Bolts (for connecting plates): Bolts for connecting plates shall be no less than ¾ inch in diameter, and shall be hot-dip galvanized. The threads shall be American

Standard Coarse Thread Series, Class 2 free fit. Bolt and nut materials shall conform to the requirements of the Specifications for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers, A.S.T.M. Designation: A 325.

The bolts may be sampled and tested before erection is commenced, or the bolts may be accepted on the manufacturer's certification.

(h) Nuts and Bolt Heads: Bolt heads and nuts shall be shaped to provide adequate bearing or standard type bolts and nuts with special washers shall be used in lieu thereof.

(i) Corrugations: Corrugations shall have a pitch of 6 inches with a tolerance of ¼ inch and a depth of 2 inches, with a tolerance of plus or minus ⅛ inch. The radius on the inside of the corrugation shall be at least 1 1/16 inches.

(j) Gage Determination and Tolerance: The gage of the plates shall be based on the weight of fabricated galvanized plates. The theoretical weight per square foot of the flat galvanized sheet and tolerances shall be as follows:

Gage	Theoretical Weight After Galvanizing (Lbs. per Sq. Ft.)	Permissible Variations in Average Weight of Lots* (In Per Cent)	
		Over	Under
1	11.406	5.5	3
3	10.156	5.5	3
5	8.906	5.5	5
7	7.656	5.5	5
8	7.031	5	5
10	5.781	5	5
12	4.531	5	5

*The term "lot" means all the plates of one gage in the shipment for gages 7 and heavier, and not less than 6,000 pounds constitutes a "lot" for gages 8 and lighter. Individual plates shall not underrun the theoretical weight by more than 10 per cent.

(k) Description of Plates: Plates shall consist of structural units of galvanized corrugated metal. Single plates shall weigh not more than 750 pounds and shall

be furnished in standard sizes to permit structure length increments of 2 feet.

The gage of plates and the radius of curvature shall be as specified on the plans.

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than 3 plates come together at any one point. Each plate shall be curved to one or more circular arcs.

Forming and Punching Plates: Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as indicated on the plans.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart, with one row in the valley and one in the crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall be not less than 1¾ times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolts by more than ⅛ inch.

Plates for forming skewed or sloped ends shall be cut so as to give the angle of the skew or slope specified. Burnt edges shall be free from oxide and burrs, shall present a workmanlike finish, and legible identification numerals shall be placed on each part plate to designate its proper position in the finished structure.

(m) Workmanship: It is the essence of these specifications that in addition to complying with the details of construction, the completed structure shall show careful finished workmanship in all particulars. Structures on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship, shall be rejected. This requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the pres-

ence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

1. Uneven laps.
2. Elliptical shaping (unless specified).
3. Variation from a straight center line.
4. Ragged edges.
5. Loose, unevenly lined or spaced bolts.
6. Illegible brand.
7. Bruised, scaled or broken spelter coating.
8. Dents or bends in the metal itself.

(n) Field Inspection and Acceptance of Plates: The field inspection shall be made by the engineer, who shall be furnished with an itemized statement of the number and length of the plates in each shipment.

Each plate included in a shipment shall fully meet the requirements of these specifications; and if 25 per cent of the plates in any shipment fail to meet the requirements the entire shipment may be rejected.

9.08 Cast Iron Culvert Pipe:

These specifications cover cast iron pipe for use in the construction of pipe culverts. Unless otherwise specified in the special provisions or on the plans, standard strength pipe shall be furnished.

All cast iron pipe shall conform to the requirements of the Specifications for Cast-Iron Culvert Pipe, A.A.S.H.O. Designation: M 64.

9.09 Vitrified Clay Sewer Pipe:

These specifications cover clay sewer pipe for use in the construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

Clay sewer pipe shall conform to the requirements of the Specifications for Standard Strength Clay Sewer Pipe, A.S.T.M. Designation: C 13.

9.10 Concrete Sewer Pipe:

These specifications cover concrete sewer pipe for use in the construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

Concrete sewer pipe shall conform to the requirements of the Specifications for Concrete Sewer Pipe, A.S.T.M. Designation: C 14.

9.11 Reinforced Concrete Sewer Pipe:

These specifications cover reinforced concrete sewer pipe for use in the construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

Reinforced concrete sewer pipe shall conform to the requirements of the Specifications for Reinforced Concrete Sewer Pipe, A.S.T.M. Designation: C 75.

CONSTRUCTION METHODS

9.12 Forming Bed for Pipe:

The width of trench (if required) shall be sufficient to permit thorough tamping of the backfill under the haunches and around the pipe but not exceeding the external diameter of the pipe by more than 12 inches except in unstable material.

The pipe shall be bedded in an earth foundation of uniform density carefully shaped, by means of a templet supported at the desired grade, to fit the lower part of the pipe exterior for at least 10 per cent of its overall height. Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with suitable material in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than ½ inch per foot height of fill over the top of the pipe, with a minimum allowable thickness of 8 inches. Where a firm foundation is not encountered at the grade established, due to soft, spongy or other unstable soil, unless other special construction methods are called for on the plans or in the special provisions, all such unstable soil under the pipe shall be removed and replaced with a foundation fill consisting of gravel or other suitable approved material properly compacted to provide adequate support for the pipe line. When foundation fill is required, in the opinion of the engineer, it shall be paid for by "Extra Work Order" as provided in Article 4.04, Division I.

If pipe 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.

9.13 Laying Pipe:

(a) General: All pipe shall be carefully laid to the lines and grades given.

Branch openings or service connections provided for future extensions shall be plugged as directed by the engineer.

Any pipe or pipe-arch which is not true in alignment or which shows settlement after laying, shall be taken up and relaid at the contractor's expense.

The interior of culvert and sewer pipe shall be kept clear of debris as the work progresses. Where practicable a swab or drag shall be kept in the pipe line and pulled forward past each joint immediately after its completion.

(b) Reinforced Concrete Pipe: Bell and spigot pipe shall be laid with the bell end upgrade. All joints in bell and spigot pipe shall be sealed with cement mortar. The mortar shall consist of one part Portland cement, 2 parts sand and sufficient water to give the proper consistency. After each section of pipe has been laid the lower portion of the bell shall be filled with mortar and the succeeding section laid in place so that the inner surface of the 2 sections are flush. The remainder of the joint shall be solidly filled with mortar and neatly troweled and finished to a 45 degree bevel beyond the edge of the bell, forming a continuous ring around the pipe. The inside of the joint shall be wiped clean and smooth.

All tongue and groove joints shall be sealed with cement mortar consisting of one part Portland cement, 2 parts sand, 1/10 part of hydrated lime or its equivalent and sufficient water to give the desired consistency. Special care shall be taken to force the mortar thoroughly into the joints.

Bells and spigots and tongues and grooves of concrete pipe must be thoroughly wetted before the mortar is placed. After the initial set, mortar on the outside of joints shall be protected from the elements with earth or other covering.

When reinforced concrete pipe is used for constructing flumes, the pipe shall be bell and spigot type only and the joints for same shall be prepared in the same manner as provided under (h), "Concrete Sewer Pipe and Reinforced Concrete Sewer Pipe," hereinafter contained.

(c) Corrugated Metal Pipe Culverts and Corrugated Metal Pipe-Arch Culverts: Corrugated metal pipe and pipe-arches shall be laid with the outside laps on the circumferential joints upgrade with the longitudinal joints on the

sides and with the ends of sections butted tightly together and connected with bands bolted firmly into place.

(d) Metal End Sections: The metal end sections shall be installed in accordance with the detailed requirements shown on the plans.

(e) Structural Plate Pipe-Arches: Structural plate pipe-arches shall be assembled in their final position and all bolts shall be drawn tight before beginning backfilling. All plates shall be paced in the order recommended by the manufacturer. Drift pins may be used to facilitate matching of holes.

(f) Cast Iron Culvert Pipe: Cast iron pipe shall be laid with the hub or interlocking end upgrade. The joints shall be prepared in accordance with the applicable requirements of the Standard Specifications for Laying Cast-Iron Pipe of the American Water Works Association.

(g) Vitrified Clay Sewer Pipe: All clay pipe shall be bell and spigot type and shall be laid with the bell end upgrade. Joints shall be prepared in the same manner as provided for "Reinforced Concrete Pipe."

(h) Concrete Sewer Pipe and Reinforced Concrete Sewer Pipe: In the event the contractor elects to use bell and spigot type pipe, in laying the sewer pipe, the bell end shall be laid upgrade and the joints shall be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than ¾ inch, and in one piece of sufficient length to pass around and lap at the top, shall be solidly rammed into the annular space between the pipe, using a suitable caulking tool. The remainder of the joint space, left after caulking the gasket, shall be solidly filled with Portland cement mortar (proportion 1:2) and neatly troweled and finished to a 45 degree bevel beyond the edge of the bell forming a continuous ring around the pipe. The bell and spigot shall be thoroughly wetted before applying the mortar to the joints and after the joints are completed shall be kept thoroughly wet by covering with wet burlap until backfilled. No backfilling shall be placed until at least 12 hours after the joint material has been placed and the completed section inspected and approved by the engineer. Walking or working on the completed pipe except as may be necessary in tamping or backfilling will not be permitted until the trench has been backfilled to a height of at least one foot above the top of the pipe.

In the event the contractor elects to use tongue and groove type sewer pipe, in laying the sewer pipe, the joints shall be made in the following manner: The first section of pipe downgrade shall be bedded to the established line and grade with the groove upgrade. The groove shall be carefully washed with a wet brush and the bottom half of the groove end buttered with mortar. A shallow excavation shall be made underneath the pipe at the joint, this space shall be filled with mortar into which the ends of the first and second sections of pipe shall bed when laid. The tongue of the next section shall be cleaned with a wet brush and a layer of mortar shall be applied to the top half of it. The tongue end of the second pipe shall then be fitted into the groove end of the first pipe until the mortar is squeezed out onto the inner and outer surfaces of the pipe. The inner surface of the pipe at the joint shall then be brushed smooth with a long handled brush, and the outside shall be pointed up with a bead of mortar. All mortar used for tongue and groove pipe shall conform to the requirements of same contained in the second paragraph under (b) "Reinforced Concrete Pipe," hereinbefore.

Prior to forming the joint, a band, consisting of a single thickness of cheese cloth not less than 8 inches wide, shall be placed under the joint so that, when the joint is completed and the bead is made, it can be brought completely around the joint and lapped or tied at the top as directed by the engineer. The cheese cloth diaper shall be dipped in Portland cement mortar just prior to placement. Paper meeting the approval of the engineer may be substituted for cheese cloth. Tying or lapping the diaper shall be completed 4 or 5 lengths behind the laying operation in order to prevent movement of the pipe and consequent loosening of the diaper. The purpose of the diaper is to hold the cement mortar band in place while curing. The cement mortar band held in place by the diaper shall have a thickness of not less than ½ inch at the joint. The cement mortar band shall be cured with a covering of moist earth, sand, canvas or burlap. The joint shall be kept thoroughly wet until backfilled. No backfilling shall be placed until at least 12 hours after the joint material has been placed and the completed section inspected and approved by the engineer. Walking or working on the completed pipe except as may be necessary in tamping or backfilling will not be permitted until the trench has been backfilled to a height of at least one foot above the top of the pipe.

9.14 Backfilling:

Selected embankment material, free from large lumps, clods, or rock shall be placed alongside the pipe in layers not exceeding 6 inches in depth and thoroughly compacted so that on each side of the pipe there shall be a berm of thoroughly compacted or undisturbed earth at least as wide as the external diameter of the pipe. Each layer, if dry, shall be moistened and then compacted by rolling or tamping with approved mechanical tampers, special care being taken to thoroughly compact the fill under the haunches of the pipe. This method of filling and compacting shall be continued until the embankment is level with the top of the pipe, if the top of the pipe is below the original surface; otherwise, it shall be continued until the embankment is level with the original surface.

9.15 Relaying Pipe:

If indicated or directed, old pipe culverts shall be removed and all suitable sections shall be relaid, extended, or renewed in the same manner as specified for new pipe culverts.

MEASUREMENT AND PAYMENT

9.16 Method of Measurement:

Culvert and sewer pipe will be measured by the linear foot. The length for measurement shall be the actual length of pipe placed and accepted. Excavation for removal of existing pipe culverts will be measured as provided under Article 4.14, Part 1, Division II.

Metal pipe ends shall be measured per each and the number to be measured shall be the number of pipe ends installed, measured separately for each size of culvert pipe.

9.17 Basis of Payment:

Pipe placed and accepted, measured as provided above, shall be paid for at the contract unit price for "Culvert Pipe," "Sewer Pipe," "Pipe-arch" and "Metal Pipe Ends," which price and payment shall constitute full compensation for furnishing, hauling and installing the pipe and metal pipe ends; for all excavation, except as provided under Article 9.16, preparation of bed and backfilling; and for furnishing of all equipment, tools, labor and incidentals and

the performance of all work necessary to complete the item, but shall not be payment for headwalls.

Payment will be made under:

Item 4-9-1, Relaying Culvert Pipe, per linear foot.

Item 4-9-2, Twelve Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-3, Fifteen Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-4, Eighteen Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-5, Twenty-four Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-6, Thirty Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-7, Thirty-six Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-8, Forty-two Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-9, Forty-eight Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-10, Fifty-four Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-11, Sixty Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-12, Seventy-two Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-13, Eighty-four Inch Reinforced Concrete Culvert Pipe (Standard Strength), per linear foot.

Item 4-9-14, Twenty-four Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-15, Thirty Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-16, Thirty-six Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-17, Forty-two Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-18, Forty-eight Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-19, Fifty-four Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-20, Sixty Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-21, Seventy-two Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-22, Eighty-four Inch Reinforced Concrete Culvert Pipe (Extra-Strength), per linear foot.

Item 4-9-23, Eight Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-24, Ten Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-25, Twelve Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-26, Fifteen Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-27, Eighteen Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-28, Twenty-one Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-29, Twenty-four Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-30, Thirty Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-31, Thirty-six Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-32, Forty-two Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-33, Forty-eight Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-34, Fifty-four Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-35, Sixty Inch Corrugated Metal Pipe Culvert, per linear foot.

Item 4-9-36, Eight Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-37, Ten Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-38, Twelve Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-39, Fifteen Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-40, Eighteen Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-41, Twenty-one Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-42, Twenty-four Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-43, Thirty Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-44, Thirty-six Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-45, Forty-two Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-46, Forty-eight Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-47, Fifty-four Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-48, Sixty Inch Corrugated Metal Pipe Culvert (Asphalt Coated), per linear foot.

Item 4-9-49, Twelve Inch Culvert Pipe, per linear foot.

Item 4-9-50, Fifteen Inch Culvert Pipe, per linear foot.

Item 4-9-51, Eighteen Inch Culvert Pipe, per linear foot.

Item 4-9-52, Twenty-four Inch Culvert Pipe, per linear foot.

Item 4-9-53, Thirty Inch Culvert Pipe, per linear foot.

Item 4-9-54, Thirty-six Inch Culvert Pipe, per linear foot.

Item 4-9-55, Forty-two Inch Culvert Pipe, per linear foot.

Item 4-9-56, Forty-eight Inch Culvert Pipe, per linear foot.

Item 4-9-57, Fifty-four Inch Culvert Pipe, per linear foot.

Item 4-9-58, Sixty Inch Culvert Pipe, per linear foot.

Item 4-9-59, 18″ x 11″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-60, 22″ x 13″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-61, 25″ x 16″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-62, 29″ x 18″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-63, 36″ x 22″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-64, 43″ x 27″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-65, 50″ x 31″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-66, 58″ x 36″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-67, 65″ x 40″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-68, 72″ x 44″ Corrugated Metal Pipe-arch, per linear foot.

Item 4-9-69, 18″ x 11″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-70, 22″ x 13″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-71, 25″ x 16″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-72, 29″ x 18″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-73, 36″ x 22″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-74, 43″ x 27″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-75, 50″ x 31″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-76, 58″ x 36″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-77, 65″ x 40″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-78, 72″ x 44″ Corrugated Metal Pipe-arch (Asphalt Coated), per linear foot.

Item 4-9-79, Metal Pipe End for Eight Inch Pipe, per each.

Item 4-9-80, Metal Pipe End for Ten Inch Pipe, per each.

Item 4-9-81, Metal Pipe End for Twelve Inch Pipe, per each.

Item 4-9-82, Metal Pipe End for Fifteen Inch Pipe, per each.

Item 4-9-83, Metal Pipe End for Eighteen Inch Pipe, per each.

Item 4-9-84, Metal Pipe End for Twenty-one Inch Pipe, per each.

Item 4-9-85, Metal Pipe End for Twenty-four Inch Pipe, per each.

Item 4-9-86, Metal Pipe End for Thirty Inch Pipe, per each.

Item 4-9-87, Metal Pipe End for Thirty-six Inch Pipe, per each.

Item 4-9-88, Metal Pipe End for Forty-two Inch Pipe, per each.

Item 4-9-89, Metal Pipe End for Forty-eight Inch Pipe, per each.

Item 4-9-90, Metal Pipe End for Fifty-four Inch Pipe, per each.

Item 4-9-91, Metal Pipe End for Sixty Inch Pipe, per each.

Item 4-9-92, Metal Pipe End for 18″ x 11″ Pipe-arch, per each.

Item 4-9-93, Metal Pipe End for 22″ x 13″ Pipe-arch, per each.

Item 4-9-94, Metal Pipe End for 25″ x 16″ Pipe-arch, per each.

Item 4-9-95, Metal Pipe End for 29″ x 18″ Pipe-arch, per each.

Item 4-9-96, Metal Pipe End for 36″ x 22″ Pipe-arch, per each.

Item 4-9-97, Metal Pipe End for 43″ x 27″ Pipe-arch, per each.

Item 4-9-98, Metal Pipe End for 50″ x 31″ Pipe-arch, per each.

Item 4-9-99, Metal Pipe End for 58″ x 36″ Pipe-arch, per each.

Item 4-9-100, Metal Pipe End for 65″ x 40″ Pipe-arch, per each.

Item 4-9-101, Metal Pipe End for 72″ x 44″ Pipe-arch, per each.

Item 4-9-102, Asphalt Coated Pipe End for Eight Inch Pipe, per each.

Item 4-9-103, Asphalt Coated Pipe End for Ten Inch Pipe, per each.

Item 4-9-104, Asphalt Coated Pipe End for Twelve Inch Pipe, per each.

Item 4-9-105, Asphalt Coated Pipe End for Fifteen Inch Pipe, per each.

Item 4-9-106, Asphalt Coated Pipe End for Eighteen Inch Pipe, per each.

Item 4-9-107, Asphalt Coated Pipe End for Twenty-one Inch Pipe, per each.

Item 4-9-108, Asphalt Coated Pipe End for Twenty-four Inch Pipe, per each.

Item 4-9-109, Asphalt Coated Pipe End for Thirty Inch Pipe, per each.

Item 4-9-110, Asphalt Coated Pipe End for Thirty-six Inch Pipe, per each.

Item 4-9-111, Asphalt Coated Pipe End for Forty-two Inch Pipe, per each.

Item 4-9-112, Asphalt Coated Pipe End for Forty-eight Inch Pipe, per each.

Item 4-9-113, Asphalt Coated Pipe End for Fifty-four Inch Pipe, per each.

Item 4-9-114, Asphalt Coated Pipe End for Sixty Inch Pipe, per each.

Item 4-9-115, Asphalt Coated Pipe End for 18″ x 11″ Pipe-arch, per each.

Item 4-9-116, Asphalt Coated Pipe End for 22″ x 13″ Pipe-arch, per each.

Item 4-9-117, Asphalt Coated Pipe End for 25″ x 16″ Pipe-arch, per each.

Item 4-9-118, Asphalt Coated Pipe End for 29″ x 18″ Pipe-arch, per each.

Item 4-9-119, Asphalt Coated Pipe End for 36″ x 22″ Pipe-arch, per each.

Item 4-9-120, Asphalt Coated Pipe End for 43″ x 27″ Pipe-arch, per each.

Item 4-9-121, Asphalt Coated Pipe End for 50″ x 31″ Pipe-arch, per each.

Item 4-9-122, Asphalt Coated Pipe End for 58″ x 36″ Pipe-arch, per each.

Item 4-9-123, Asphalt Coated Pipe End for 65″ x 40″ Pipe-arch, per each.

Item 4-9-124, Asphalt Coated Pipe End for 72″ x 44″ Pipe-arch, per each.

Item 4-9-125, 76″ x 57″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-126, 92″ x 65″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-127, 106″ x 73″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-128, 123″ x 81″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-129, 142″ x 91″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-130, 154″ x 100″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-131, 169″ x 105″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-132, 188″ x 115″ Structural Plate Pipe-arch, per linear foot.

Item 4-9-133, Twelve Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-134, Fourteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-135, Sixteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-136, Eighteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-137, Twenty Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-138, Twenty-four Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-139, Thirty Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-140, Thirty-six Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-141, Forty-two Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-142, Forty-eight Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.

Item 4-9-143, Twelve Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-144, Fourteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-145, Sixteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-146, Eighteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-147, Twenty Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-148, Twenty-four Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-149, Thirty Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-150, Thirty-six Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-151, Forty-two Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-152, Forty-eight Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.

Item 4-9-153, Four Inch Clay Sewer Pipe, per linear foot.

Item 4-9-154, Six Inch Clay Sewer Pipe, per linear foot.

Item 4-9-155, Eight Inch Clay Sewer Pipe, per linear foot.

Item 4-9-156, Ten Inch Clay Sewer Pipe, per linear foot.

Item 4-9-157, Twelve Inch Clay Sewer Pipe, per linear foot.

Item 4-9-158, Fifteen Inch Clay Sewer Pipe, per linear foot.

Item 4-9-159, Eighteen Inch Clay Sewer Pipe, per linear foot.

Item 4-9-160, Twenty-one Inch Clay Sewer Pipe, per linear foot.

Item 4-9-161, Twenty-four Inch Clay Sewer Pipe, per linear foot.

Item 4-9-162, Twenty-seven Inch Clay Sewer Pipe, per linear foot.

Item 4-9-163, Thirty Inch Clay Sewer Pipe, per linear foot.

Item 4-9-164, Thirty-three Inch Clay Sewer Pipe, per linear foot.

Item 4-9-165, Thirty-six Inch Clay Sewer Pipe, per linear foot.

Item 4-9-166, Four Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-167, Six Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-168, Eight Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-169, Ten Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-170, Twelve Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-171, Fifteen Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-172, Eighteen Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-173, Twenty-one Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-174, Twenty-four Inch Concrete Sewer Pipe, per linear foot.

Item 4-9-175, Eighteen Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-176, Twenty-one Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-177, Twenty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-178, Twenty-seven Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-179, Thirty Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-180, Thirty-three Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-181, Thirty-six Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-182, Forty-two Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-183, Forty-eight Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-184, Fifty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-185, Sixty Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-186, Sixty-six Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-187, Seventy-two Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-188, Seventy-eight Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-189, Eighty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-190, Ninety Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-191, Ninety-six Inch Reinforced Concrete Sewer Pipe, per linear foot.

Item 4-9-192, One Hundred Eight Inch Reinforced Concrete Sewer Pipe, per linear foot.

DIVISION II

Part 5—Incidental Construction

INDEX

PART 5—DIVISION II

SECTION 1

BEARING PILES

1.01 Description:

This item shall consist of furnishing and driving precast concrete, untreated or treated timber, steel bearing

and cast in place concrete piles, of the kind and dimensions designated, complying with these specifications, and driven to the required penetration and in accordance with the lines and spacing shown on the plans.

1.02 Equipment:

(a) Drivers for Concrete Piles: Concrete piles shall be driven with single acting steam hammers unless the engineer's permission in writing is obtained for use of other types. Steam hammers used for this purpose shall develop not less than the following energy:

For 12-inch piles	7,000 ft. lbs. per blow
For 14-inch and 16-inch piles	15,000 ft. lbs. per blow
For 18-inch piles	24,000 ft. lbs. per blow
For 20-inch and 24-inch piles	30,000 ft. lbs. per blow

(b) Drivers for Timber Piles: Timber piles shall be driven with either a steam or gravity hammer. Single acting and double acting steam hammers shall develop an energy per blow at each full stroke of the piston of not less than 6,000 foot pounds nor more than 8,500 foot pounds. Gravity hammers shall weigh not less than 2,000 pounds. The fall shall be so regulated as to avoid injury to the pile and in no case shall exceed 15 feet.

(c) Drivers for Steel Bearing Piles: Steel bearing piles may be driven with single acting or double acting steam hammers or with a gravity hammer. The type of hammer used shall be approved by the engineer, subject to satisfactory performance under driving conditions encountered on the project. Single acting or double acting steam hammers shall develop an energy per blow at each full stroke of the piston of not less than 7,000 foot pounds nor more than 15,000 foot pounds. Gravity hammers shall not weigh less than 3,000 pounds. The fall of the hammer shall be so regulated as to avoid injury to the pile and in no case shall exceed 15 feet.

(d) Drivers for Cast in Place Concrete Piles: Unless otherwise provided, shells for cast in place concrete piles may be driven with a single acting steam or gravity hammer. The type of hammer used shall be approved by the engineer subject to satisfactory performance under driving

conditions encountered on the project. Steam hammers shall develop an energy per blow at each full stroke of the piston of not less than 7,000 foot pounds nor more than 15,000 foot pounds. Gravity hammers shall not weigh less than 2,000 pounds. The fall of the hammer shall be so regulated as to avoid injury to the pile and in no case shall exceed 8 feet.

(e) Leads: Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except when piles are driven through water, the leads preferably shall be of sufficient length to avoid the use of a follower.

Inclined leads shall be used in driving battered piles.

(f) Jets: When water jets are used, the number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to produce 350 gallons of water per minute under a pressure of at least 150 pounds per square inch. A pressure gauge shall be provided on the discharge pipe.

MATERIALS

1.03 Precast Concrete Piles:

Precast concrete piles shall be constructed of Class A concrete. The concrete used shall comply with the requirements of Section 5, Part 4, Division II.

Reinforcing steel used in concrete piles shall conform to the requirements of Section 6, Part 4, Division II, and the dimensions shall be as shown on the plans.

1.04 Timber Piles:

(a) Untreated Piles: Untreated piles may be of any species of wood which will satisfactorily withstand driving.

(b) Treated Piles: Treated piles shall be Southern Yellow Pine except as otherwise provided herein or on the plans or in the special provisions. When piles as required by the plans are of such length that they are unobtainable in Southern Yellow Pine, Douglas Fir piles will be permitted.

Piles shall be treated with 80-20 creosote coal-tar solution. Piles of Southern Yellow Pine shall receive 16 pounds

per cubic foot treatment, except that when provided on the plans or in the special provisions, Southern Yellow Pine piling to be used in coastal waters shall receive 20 pounds per cubic foot treatment. Piles of Douglas Fir shall receive 12 pounds per cubic foot treatment. Treatment of piling shall be in accordance with the applicable requirements of the specifications under "Preservative Treatments for Timber," Section 3, Part 5, Division II.

(c) Quality: All wood piling shall be cut from sound and live trees, preferably during the winter season. They shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed 4 inches or ⅓ of the diameter of the stick at the point where it occurs. Any defect or combination of defects which will impair the strength of the pile more than the maximum allowable knot shall not be permitted. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than 4 inches in diameter as directed by the engineer.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 per cent of the inner bark. No strip of inner bark remaining on the stick shall be over ¾ inches wide or over 8 inches long, and there shall be at least one inch of clean wood surface between any 2 such strips. Not less than 80 per cent of the surface on any circumference shall be clean wood.

Piles shall be cut above the ground swell and shall taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside of the center of the pile at any point more than one per cent of the length of the pile. In short bends, the distance from the center of the pile to a line stretched from the center of the pile above the bend to the center of the pile below the bend shall not exceed 4 per cent of the length of the bend or a maximum of 2½ inches. All knots shall be trimmed close to the body of the pile.

(d) Dimensions: Piles shall have a minimum diameter at the tip, measured under the bark, as follows:

Length of pile	Tip diameter
Less than 40 feet	8 inches
40 to 60 feet	7 inches
Over 60 feet	6 inches

The minimum diameter of piles at a section 3 feet from the butt, measured under the bark, shall be as follows:

Length of pile	Diameter in inches	
	Douglas Fir Southern Yellow Pine Southern Cypress	All other Species
20 feet and under	11	11
Above 20 to 30 feet	12	12
Above 30 to 40 feet	12	13
Over 40 feet	13	14

The diameter of the pile at the butt shall not exceed 20 inches. The diameter of the pile in cases where the tree is not exactly round shall be determined either by measuring the circumference and dividing the number of inches by 3.14, or by taking the average of the maximum and minimum diameters at the location specified.

1.05 Steel Bearing Piles:

Steel bearing piles shall consist of structural steel shapes of the section provided on the plans or as otherwise specified. The steel shall conform to the requirements for "Structural Steel," Section 7, Part 4, Division II. Specific reference is made to Article 7.03 (a).

1.06 Cast in Place Concrete Piles:

(a) Steel Shells: The design and shape of shells shall be as shown on the plans. Either type shown on the plans may be furnished, however, the same type shall be used throughout the structure.

(b) Concrete: Concrete shall be Class A conforming to the applicable requirements of Section 5, Part 4, Division II.

(c) Reinforcing Steel: Reinforcing steel shall meet the applicable requirements for "Deformed Reinforcing Steel" of Section 6, Part 4, Division II.

CONSTRUCTION METHODS

1.07 General:

(a) Order List of Piling: Unless order lengths are shown on the plans, the engineer will furnish the contractor with an itemized list showing the number and length of all piles which will be required and the contractor shall furnish piles in accordance with such itemized list.

In determining lengths of piles for ordering and for footage to be included in the contract, the lengths given in the order list shall 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.

(b) Piling Inspections: The contractor shall furnish the Department, through the engineer, a copy of each of his orders for creosoted and untreated piling in order that the Department may supply their inspectors with copies of the orders. Inspections will not be made of materials for which copies of orders have not been received by the Department and supplied by them to inspectors.

1.08 Casting Concrete Piles:

(a) Beginning of Work: The contractor shall not begin the manufacture of permanent precast concrete piling nor order, or have delivered on the job, steel reinforcement for same until he has been furnished the lengths and number required by the engineer.

All concrete piles to be used as permanent piles shall be cast at the site of work and hauling of concrete piles to be used as permanent piles from other locations will not be permitted.

(b) Pouring: Concrete shall be placed and vibrated in accordance with the general method of placing concrete as specified under Article 5.18, Part 4, Division II. The piles shall be cast separately or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until 4 days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed continuously between each pile. The completed piles shall be free from stone pockets, porous spots, or other defects, and be straight and true to form specified. The forms shall be true to

line and a 1½ inch chamfer strip shall be used in all corners; they shall be watertight and shall not be removed within 12 hours after pouring when the average temperature is above 65°F, nor within 24 hours after pouring when the average temperature is 65°F or below. Forms and removal of same shall otherwise conform to the respective requirements of Articles 5.17 and 5.25, Part 4, Division II.

All exposed surfaces of the pile shall be given a rubbed finish, in accordance with the applicable requirements of Article 5.26, Part 4, Division II.

(c) Curing: Concrete piling shall be cured as required for concrete, Article 5.24, Part 4, Division II, which curing shall begin as soon as possible after completion of placement of the concrete. The surface of the concrete shall be kept continually wet during the curing period, which shall be continued for a period of not less than 14 days after placement.

(d) Marking: Each pile shall be stamped or marked with the date of its manufacture and with a number. Lifting points indicated on plans shall be plainly marked.

(e) Handling: Piles may be removed from the form bed when they have attained a flexural strength of 500 pounds per square inch, or a compressive strength of 3,000 pounds per square inch, as determined by either beam or cylinder tests, except as hereinafter provided. Test specimens shall be made from the same concrete and cured under the same conditions as the concrete piles. For the test beams the Method of Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading), A.S.T.M. Designation: C 78, shall be used, except that the test beam will be made in the field and the sampling of concrete for molding specimens and storing of the test beams shall be done in the same manner as provided for the test cylinders. For the test cylinders, the Method of Test for Compressive Strength of Molded Concrete Cylinders, A.S.T.M. Designation: C 39, shall be used.

The concrete piles may be removed from the form beds when the concrete has attained strength equal to or greater than that indicated in the preceding paragraph, however, in no event shall the piles be removed from the forms before the expiration of 10 calendar days.

Upon removal from form beds the concrete piles shall be placed in a curing pile and separated from each other by wood spacing blocks.

Piles shall be handled carefully, avoiding dropping or severe jarring while in a horizontal position.

The concrete piles shall be lifted by means of a suitable equalizing sling or bridle attached to the pile at the lifting points designated on the plans.

(f) Age Before Driving: Concrete piles may be driven at any time after the expiration of 4 calendar days after the piles have been removed from the form beds.

(g) High Early Strength Portland Cement: The use of high early strength cement in concrete piles, other than as may be provided on the plans or in the special provisions, will not be permitted without the written consent of the engineer.

The use of high early strength cement when permitted on the request of and for the convenience of the contractor will be at the contractor's responsibility. This responsibility shall extend to the replacement by the contractor at his own expense of any defective work which may result from the use of high early strength cement, no matter what the extent of the replacement may be. Request for permission to use high early strength cement in concrete piles other than as may be provided on the plans or in the special provisions must be in writing and addressed to the engineer.

When high early strength cement is used in concrete piles, the concrete must be maintained in a saturated condition for at least 72 hours.

The requirements of (e), "Handling," and (f), "Age Before Driving," shall apply with the following exceptions:

Concrete piles may be removed from the form beds when the concrete has attained strength equal to or greater than that required, however, in no event shall the piles be removed from the forms before the expiration of 7 calendar days.

Piles may be driven at any time after the expiration of 3 calendar days after the piles have been removed from the form beds.

1.09 Pouring Cast in Place Concrete Piles:

Cast in place concrete piles shall be steel encased. The steel casings or shells shall be driven to the required penetration and after placing the reinforcing steel, shall be filled with concrete, subsequent to their inspection and approval by the engineer. The contractor shall provide a suitable light for the inspection of each shell after it has

been driven to penetration required. The shell shall be cleaned of all debris and pumped dry before placing concrete. The concrete shall be placed in the shell immediately after mixing and in no case shall concrete be used which does not reach its final position in the shell within 45 minutes after water is first added to the mix. The concrete shall be handled by a method approved by the engineer, in such a manner as to prevent segregation of aggregate in the mix. All piles shall be filled with concrete to the cutoff level. Reinforcing steel of the size and spacing shown on the plans shall be securely fastened together so as to form a rigid cage. Care shall be taken to hold the reinforcement in true position in the shell when pouring concrete. Concrete blocks or other 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. Driving of additional piles within a radius of 10 feet of a completed pile will not be permitted until the concrete has set for at least 36 hours.

1.10 Driving:

(a) General:

1. Preparation for Driving: All excavation of foundation or filling of embankment in which piles are to be driven shall be completed before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles leaving clean, solid surfaces to receive the concrete in excavations.

2. Protection of Heads: Concrete Piles: The heads of all concrete piles shall be protected during driving by using driving caps of an approved design, preferably having a rope or other suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

Timber Piles: The heads of timber piles shall be protected during driving by a driving cap of an approved design to prevent any brooming, splitting or other injury to the pile. When the area of the head of pile is greater than that of the face of the hammer, a cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile head, and thus avoid as far as possible, the tendency to split or shatter the pile.

Steel Bearing Piles: The heads of steel bearing piles shall be protected during driving by a cast steel driving head provided with a wooden block to receive the impact from the hammer. The head shall fit closely over the top of the pile and shall extend down at least 4 inches on the pile head, in order to permit toggling of the pile when necessary.

Cast in Place Concrete Piles: Shells shall be protected during driving by the use of driving heads, mandrels, or other devices in accordance with the manufacturer's recommendation so that the piling may be driven without injury.

3. Jetting: Adequate water jet equipment shall be provided and used where necessary or when directed by the engineer. Where jetting is used, the hammer shall be used in conjunction therewith and 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, preferably 2 feet.

4. Followers: The driving of piling with followers shall be avoided if practicable and shall be done only under written permission of the engineer. When followers are used, one pile from every group of 10 shall be a long pile driven without a follower, and shall be used as a test pile to determine the average bearing power of the group.

5. Defective Piles: The procedure incident to the driving of piles shall not subject them to excessive and undue abuse causing injury to the pile. Any pile so injured in driving or handling shall be replaced by a new pile, or otherwise corrected to the satisfaction of the engineer.

Any pile so out of line or plumb as to impair its usefulness or the appearance of the structure shall be removed and re-driven, or cut off below ground level and rebuilt, or an additional pile driven to replace it, whichever is approved by the engineer.

Any pile pushed up by the driving of adjacent piles or by any other cause shall be re-driven to the required penetration.

A concrete pile shall be considered defective if it has a visible crack, or cracks,, extending around 3 sides of the pile, or any similar defect, which in the opinion of the engineer, affects the strength or life of the pile.

6. Interrupted Driving: When driving is interrupted before final penetration is reached, the record for

penetration shall not be taken until after at least 12 inches penetration has been obtained upon resumption of driving.

7. Extent of Driving: Driving shall be continued until plan cut-off is reached or until a rate of penetration satisfactory to the engineer is obtained. If proper resistance to driving is not obtained at cut-off, the driving shall be continued and the additional length of pile required shall be supplied by splicing.

8. Determination of Bearing Values: The safe bearing values shall be determined by that one of the following formulas appropriate to the case:

For gravity hammers $P = \frac{2\,WH}{S+1.0}$

For single-acting steam hammers $P = \frac{2\,WH}{S+0.1}$

For double-acting steam hammers $P = \frac{2\,H(W+Ap)}{S+0.1}$

Where P = safe bearing power in pounds,
W = weight, in pounds, of striking parts of hammer,
H = height of fall in feet,
A = area of piston in square inches,
p = steam pressure in pounds per square inch at the hammer,
S = the average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam hammers.

The above formulas are applicable only when:

I. The hammer has a free fall.
II. The head of the pile is not broomed or crushed.
III. The penetration is reasonably quick and uniform.
IV. There is no sensible bounce after the blow
V. A follower is not used.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

Unless otherwise ordered by the engineer, timber piling shall be driven to the bearing value given on the plans or in the special provisions. If bearing values are not given, timber piling shall be driven to a minimum value of 20 tons.

In case water jets are used in connection with the driving, the bearing power shall be determined by the above formulas from the results of driving after the jets have been withdrawn, or a load test may be applied.

In all cases when tested by formula, piles shall be driven until their safe bearing power is not less than the pile loadings shown on the plans.

In case the safe bearing power of any pile is found by test, or by formula if not tested, to be less than the load that it was intended to carry, additional piles shall be driven until the load per pile is reduced to the safe bearing power found, or plans showing the necessary modification of the design of the footings and the number and location of the piles required will be furnished by the engineer and the work constructed accordingly.

(b) Concrete Piles:

1. Storage and Handling: For precast piles, the method of storing and handling shall be such as to eliminate the danger of fracture by impact or undue bending stresses in curing or transporting the piles from the molds and into the leads. In general, concrete piles shall be lifted by means of a suitable bridle or sling attached to the pile at points designated on the plans. In no case shall the method of handling be such as to induce stresses in the concrete of more than 650 pounds compression per square inch, or in the reinforcing steel in excess of 12,000 pounds per square inch, allowing 100 per cent of the calculated load for impact and shock effects.

In handling piles for use in sea water or alkali soils, special care shall be exercised to avoid injury to the surface of the pile.

2. Extensions: Extensions shall be avoided but when necessary they shall be made as follows:

After driving is completed, the concrete at the end of the pile shall be cut away leaving the reinforcing steel exposed for a length of 35 diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be securely fastened to the projecting steel and the necessary form work shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used originally in the pile. Just prior to placing concrete, the top of the pile shall be cleaned of all loose particles, thoroughly wetted and covered with a

thin coating of neat cement, retempered mortar or other suitable bonding material. The forms shall remain in place not less than 7 days and shall then be carefully removed and the entire exposed surface of the pile finished as above specified.

(c) Timber Piles:

1. Seasoning After Treatment: Treated piles shall not be driven until they have been seasoned a minimum of 7 days after treatment.

2. Storage and Handling: The method of storage and handling shall be such as to avoid injury to the piling. Special care shall be taken to avoid breaking the surface of treated piles; cant dogs, hooks or pike-poles shall not be used. Cuts or breaks in the surface of treated piling shall be given 2 brush coats of hot creosote oil of approved quality and hot creosote oil shall be poured into all bolt holes.

3. Collars: Collars or bands to protect piles against splitting and brooming shall be provided where necessary by the contractor at his own expense.

4. Pointing: Piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes of a design satisfactory to the engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

5. Splicing Piles: Full length piles shall always be used where practicable but if splices cannot be avoided, the method of splicing shall be that given below. Piles shall not be spliced except by the written permission of the engineer, and when this work is done under his direction, it will be measured and paid for as hereinafter specified under "Measurement and Payment."

Wherever the engineer considers it necessary to splice piles which are delivered on the work, the splices shall be made in accordance with the Department's standard splice plan. This splice consists of 4—3-inch x 8-inch creosoted timbers 8 feet long, bolted to each section of pile with 7—¾-inch x 16-inch bolts with ogee washers, after each section of pile has been squared up to a minimum distance of 4 feet back from splice.

6. Elevation of Cut-Off: The tops of all piling shall be sawed off at right angles to their axis at the elevation indicated on the plans or as directed by the engineer.

Piles which support timber caps shall be sawed to a horizontal plane and shall exactly fit the superimposed structure. Broken, split or misplaced piles shall be withdrawn and properly replaced. Piles driven below the cut-off grade fixed by the engineer shall be withdrawn and replaced by new and, if necessary, longer piles, at the expense of the contractor. Timber piling supporting concrete footings shall be embedded at least 12 inches in the footing.

7. Treatment of Heads: After having been cut to receive the caps, and prior to placing the caps, pile heads shall be treated to prevent decay.

The heads of treated piles shall be treated as follows, unless a concrete cap is to be placed on the piles:

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, size 20″ x 20″, saturated with hot asphalt, followed by a 24″ x 24″ number 28 gage galvanized metal cover. The cover shall be bent down over the pile at an angle of approximately 45 degrees.

(d) Steel Bearing Piles:

1. Splices: Steel bearing piles shall be furnished and driven in full lengths unless splices are indicated on the plans or authorized by the engineer in order to secure lengths longer than those shown on the plans. The number of splices shall be kept to a minimum. Preferably, splices shall be limited to not more than one splice per pile, and in no event shall one pile have more than 2 splices. When splices are authorized they shall be made in accordance with the details shown on the plans.

2. Cut-Offs: Cut-offs of steel bearing piles shall be made at right angles to the axis of the pile. The cuts shall be made in clean, straight lines and any irregularity due to cutting or burning shall be leveled off with deposits of weld metal prior to placing bearing caps.

3. Painting: Steel bearing piles shall be given one shop coat of red lead paint over the full length of piling. After driving, the entire surface of pile above low water or the ground line shall be given the first and second field coats of red lead paint and the third field coat of aluminum paint.

Painting of steel bearing piles shall conform to the applicable requirements of Section 4, Part 5, Division II.

(e) Cast in Place Concrete Piles:

1. Order Lengths: Unless otherwise specified, the contractor shall order shells for cast in place piles, prefabricated in lengths specified.

2. Splicing Piles: Field splicing will be permitted but sections which in the opinion of the engineer are too short shall not be used. The plans may show section lengths for the various types of shells permitted for use. When shown, the sections shall be furnished in the specified lengths and splices as required may be made before shipment or in the field as the contractor elects. Field splices of shell sections shall be made in accordance with the manufacturer's recommendations and to the satisfaction of the engineer. Welding, where used, shall be in accordance with the current Standard Specifications for Welded Highway and Railway Bridges of the American Welding Society.

3. Cut-Offs: 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 elevation specified.

4. Painting: The shells shall be given one shop coat of red lead paint over the full length of the shell. After driving, the entire surface of the shell above low water or the ground line shall be given the first and second field coats of red lead paint and the third field coat of aluminum paint.

Painting of steel shells shall conform to the applicable requirements of Section 4, Part 5, Division II.

1.11 Test Piles:

(a) Unloaded: When called for in the contract, the contractor shall drive test piles of the dimensions and at the locations designated by the plans. They shall be of the same material as the permanent piles. Unless otherwise specified on the plans they shall be of the same cross section as the permanent piles.

The use of prefabricated concrete test piles, furnished by the contractor without inspection at the time of casting, will be permissible but solely at the responsibility of the contractor for satisfactory driving results. Visible defects at delivery to site of driving will be grounds for mandatory rejection.

In general, the contractor will be required to drive one test pile for each foundation, and in trestle work at about 300 foot intervals.

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, as shown on plans, and keep this hole open during the driving and loading of the test piles so that the driving and loading conditions will be representative of actual conditions of load on the permanent piles.

Test piles shall be driven in accordance with the specifications for the particular type of piling shown on the plans. They shall be driven until the capacity, as determined by the formulas hereinbefore, is equal to the load shown on the plans, or until the required penetration is obtained, unless otherwise directed by the engineer.

In case it is necessary, as determined by the engineer, to jet any piles, it shall be done in accordance with the specifications for this class of work under Article 1.10 (a).

(b) Loading: After the test pile has been driven in accordance with these specifications, and, if loading is specified in the contract, the contractor will be required to submit to the engineer for approval detailed plans of the loading apparatus he intends to use, and in designing same, care must be taken to allow the various increments of the load to be placed gradually without causing vibration in the test pile.

The piles shall be loaded by means of a hydraulic jack reacting against a beam fastened to anchor piles driven around the test pile or against a loaded platform, or a combination of the two. If anchor piles, or piles to support the loaded platform are used, the piles shall be at least 5 feet from the test pile.

The test piles after being driven to the required penetration shall be allowed to stand undisturbed for such period of time as may be provided on the plans or in the special provisions before beginning loading operations.

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 twice the design load by adding additional load in 3 equal increments. A period of 6 hours shall intervene between each increment of load, except that in the event that the pile is still settling at the end of the 6 hour period, the interval may be extended at the discretion of the engineer.

Upon attaining twice the design load on the pile or upon finding a gross settlement of ½ inch in the pile, if this

should occur before the loading is completed up to twice the design load, the loading shall be halted and the pile allowed to stand under this load for a period of 48 hours. At the end of the 48 hour period, providing there has been no settlement during the last 24 hours, the load shall be removed and the pile allowed to stand for 6 hours without any load. However, should settlement continue into the second 24 hour period, the load shall remain in place a sufficient length of time beyond the expiration of the 48 hours to show that the test load does not cause further settlement under the final 24 hour period. The load shall then be removed and the pile allowed to stand for 6 hours without any load. Readings shall then 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 that load which does not cause a greater permanent settlement than ¼ inch, measured at the top of the pile, after a minimum of 48 hours load application, the last 24 hours of which shall be without any increase in settlement.

After completion of the 48 hour test, twice the pile design load shall be replaced on the pile as the first increment and the loading continued by increments as described above, each increment to be approximately equal to ⅓ the pile design load, until a total settlement of one inch has been exceeded or a total load of 100 tons has been applied to a concrete or steel pile, or 50 tons to a timber pile, as the case may be.

Concrete filling and reinforcing steel will not be required for "Cast in Place Concrete Test Piles." However, the theoretical weight of the reinforced concrete (computed at 150 pounds per cubic feet) shall be added to the design load to be used as a test load on these piles.

(c) Utilizing Test Piles: After the completion of the loading tests, the load shall be removed as directed and the piles utilized in the structure if found satisfactory for use or disposed of in such other manner as ordered by the engineer. Test piles not loaded shall be utilized similarly. Cast in place concrete test piles which are not pulled shall be cut off below the ground line and the contractor shall fill the shell with earth, except that the top 5 feet shall be plugged with concrete, covered with earth and leveled off.

1.12 Pilot Holes:

When called for in the proposal, pilot holes shall be bored or dug to permit pile penetration into hard soil formations. The holes shall have, in general, a diameter of approximately ⅔ of the face width of the pile but shall, however, be of a size which will provide the desired results of proper pile penetration and carrying capacity. The number of pilot holes shall be determined by the engineer. The holes shall be bored or dug to a depth of 2 to 3 feet less than the penetration of the pile and the remaining penetration shall be obtained by driving.

MEASUREMENT AND PAYMENT

1.13 Method of Measurement:

(a) Piling: 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.

(b) Cut-Offs: Cut-offs made as directed by the engineer, will be measured by the linear foot, except cut-offs of steel piles. Measurement 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 measurement of cut-offs be made where they have been necessitated by crushing, brooming, splitting or other injuries resulting from careless driving.

No measurement will be made for required cut-offs of steel piling, including steel shells, and such cut-offs will remain the property of the contractor.

(c) Extensions: Measurement of extensions on precast concrete piles will be made by the linear foot, complete in place. Measurement will be made as follows: The length of cut-back on the original 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 2 to determine the quantity for measurement, which measurement shall include any additional driving that may be required. No deduction will be made from the original length of pile driven due to cut-back.

Measurement of extensions on all other types of piles will be made by the linear foot complete in place, for that portion of the pile added to the original length of pile driven.

No measurement will be made for extensions necessitated by damage to the pile during driving.

(d) 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 shall be by the linear foot, the number of linear feet will be determined by allowing 10 linear feet of piling for each splice made. The total number of linear feet of piling driven shall 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 at the direction and under the supervision of the engineer.

3. Steel Bearing Piles: Measurement of splices on steel bearing piles will be made by the linear foot; the number of linear feet will be determined by allowing 2 linear feet of piling for each splice made. The total number of linear feet of piling driven shall 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 at the direction and under supervision of the engineer.

4. Cast in Place Concrete Piles: Splices for cast in place concrete piles will not be measured as a splice.

(e) Jetting: The number of jetted piles to be paid for shall be the number of individual piles of any type jetted into place at the direction of the engineer.

(f) Unloaded Test Piles: The number of test piles to be paid for shall be the number of individual piles of each type furnished and driven as directed by the engineer. Cut-offs of test piles shall not be included in any pay footage. Test piles pulled and re-used as permanent piles shall be measured as provided above under paragraph (a).

(g) Loading Test Piles: The number of load tests to be paid for shall be the number of load tests made, completed and accepted.

(h) Pilot Holes: The number of pilot holes to be paid for shall be the number of holes completed and accepted by the engineer.

1.14 Basis of Payment:

(a) Piling: The number of linear feet of completed and accepted piling, measured as specified, shall be paid for at the contract unit price per linear foot for "Precast Con-

crete Piles," "Steel Bearing Piles," "Untreated Timber Piles," "Treated Timber Piles," or "Cast in Place Concrete Piles," which price and payment shall constitute full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the item. This price shall include 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.

(b) Cut-Offs: Payment for cut-offs, measured as specified, shall be made at the rate of ½ the contract unit price per linear foot for the particular type of pile which has been cut off. No payment will be made for cut-offs of steel piling.

(c) Extensions: Payment for extensions shall be made at the contract unit price per linear foot for the size of pile being extended, measured as provided above, which price and payment shall constitute full payment for all materials, equipment and labor required to complete the item in accordance with these specifications.

(d) Splices: Payment for splices, measured as specified, shall be made at the contract unit price per linear foot for the particular type of piles spliced, which price and payment shall constitute full compensation for all materials, equipment and labor required to make the splice.

(e) Jetting: Payment for jetting piles, measured as specified, shall be made at the contract unit price per pile jetted, which price and payment shall constitute full compensation for all materials, equipment and labor required to jet the pile.

(f) Unloaded Test Piles: This work shall be paid for at the contract unit price each for "Unloaded Test Piles," complete in place. This price shall include the test pile and all materials, equipment, tools, jetting, labor, and work incidental thereto. No payment will be made for test piles driven that are not in accordance with these specifications or as directed by the engineer and accepted by him.

(g) Loading Test Piles: This work shall be paid for at the contract unit price each for "Loading Test Piles." This price shall include all materials, equipment, tools, labor and work incidental to constructing the temporary installations necessary in loading the test pile and removing and disposing of same as directed by the engineer. No payment will be made for test loadings that are not made in accord-

ance with these specifications or as directed by the engineer and accepted by him.

(h) Pilot Holes: Payment for pilot holes shall be made at the contract unit price for each hole completed and accepted, which price and payment shall constitute full compensation for all materials, equipment and labor required to complete the item.

Payment will be made under:

Item 5-1-1, 12 Inch Precast Concrete Piles, per linear foot.
Item 5-1-2, 14 Inch Precast Concrete Piles, per linear foot.
Item 5-1-3, 16 Inch Precast Concrete Piles, per linear foot.
Item 5-1-4, 18 Inch Precast Concrete Piles, per linear foot.
Item 5-1-5, 20 Inch Precast Concrete Piles, per linear foot.
Item 5-1-6, 24 Inch Precast Concrete Piles, per linear foot.
Item 5-1-7, Untreated Timber Piles, per linear foot.
Item 5-1-8, Treated Timber Piles, per linear foot.
Item 5-1-9, 8" x 8" 36# Steel Bearing Piles, per linear foot.
Item 5-1-10, 10" x 10" 42# Steel Bearing Piles, per linear foot.
Item 5-1-11, 10" x 10" 57# Steel Bearing Piles, per linear foot.
Item 5-1-12, 12" x 12" 53# Steel Bearing Piles, per linear foot.
Item 5-1-13, 12" x 12" 74# Steel Bearing Piles, per linear foot.
Item 5-1-14, 14" x 14½" 73# Steel Bearing Piles, per linear foot.
Item 5-1-15, 14" x 14½" 89# Steel Bearing Piles, per linear foot.
Item 5-1-16, 14" x 14½" 102# Steel Bearing Piles, per linear foot.
Item 5-1-17, 14" x 14½" 117# Steel Bearing Piles, per linear foot.
Item 5-1-18, 12" Cast in Place Concrete Piles, per linear foot.

Item 5-1-19, 14″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-20, 16″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-21, 18″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-22, 20″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-23, 22″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-24, 24″ Cast in Place Concrete Piles, per linear foot.
Item 5-1-25, Jetting Piles, per each.
Item 5-1-26, Unloaded Concrete Test Piles, per each.
Item 5-1-27, Unloaded Timber Test Piles, per each.
Item 5-1-28, Unloaded Steel Bearing Test Piles, per each.
Item 5-1-29, Unloaded Cast in Place Concrete Test Piles, per each.
Item 5-1-30, Loading Test Piles, per each.
Item 5-1-31, Pilot Holes, per each.

SECTION 2

SHEET PILING

2.01 Description:

This specification covers only sheet piling shown on the plans, or ordered by the engineer to be left in place so that it becomes a part of the finished structure.

MATERIALS

2.02 Timber Sheet Piles:

(a) General: Timber sheet piles shall be untreated unless the plans specifically provide for the use of treated timber.

The piles shall be of the thickness specified or 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 of 3 planks securely fastened together.

The piles shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together.

(b) Untreated Timber Sheet Piles: The timber, unless otherwise definitely noted upon the plans or in the special provisions, 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, or other defects which might impair its strength or tightness.

(c) Treated Timber Sheet Piles: Treated timber may be either Southern Pine or Douglas Fir, meeting the applicable requirements of Section 8, Part 4, Division II. Timber shall be treated with creosote oil in conformity with the applicable requirements of Section 3, Part 5, Division II.

(d) Hardware: Hardware furnished shall be in accordance with the requirements of Article 3.03, Part 4, Division II.

2.03 Concrete Sheet Piles:

The materials entering into the construction of concrete sheet piles shall comply with the following requirements:

(a) Concrete: Concrete shall be Class A meeting the applicable requirements of Section 5, Part 4, Division II.

(b) Reinforcing Steel: Reinforcing steel shall be "Deformed Reinforcing Steel" meeting the applicable requirements of Section 6, Part 4, Division II.

2.04 Steel Sheet Piles:

Steel sheet piles shall be of the type and weight indicated on the plans or designated in the special provisions, conforming to the requirements of the Specifications for Steel Sheet Piling, A.S.T.M. Designation: A 328.

A minimum tensile strength of 60,000 pounds per square inch will be permitted for pilings used in the fabrication of corners, tees, etc.

Bend Tests: Bend test specimens shall stand being bent cold through 180° around a pin, the diameter of which is equal to twice the thickness of the specimen, without cracking on the outside of the bent portion.

Miscellaneous Requirements: All piling shall conform in other respects—test specimens, number of tests, finish, marking and inspection—to the requirements of the Speci-

fications for Steel for Bridges and Buildings, A.S.T.M. Designation: A 7.

Painting: The steel sheet piles shall be given one shop coat of red lead paint over the full length of the piling. After driving, the entire surface of the sheet piling above low water or the ground line shall be given the first and second field coats of red lead paint and the third field coat of aluminum paint.

Painting of steel sheet piles shall conform to the applicable requirements of Section 4, Part 5, Division II.

CONSTRUCTION METHODS

2.05 Construction:

Timber, concrete and steel sheet piling shall be constructed in strict accordance with the detailed design shown on the plans.

2.06 Driving:

Sheet piling shall be driven with a maul, sledge, gravity or steam hammer, as approved by the engineer.

2.07 Jetting:

In case it is necessary, in order to obtain the penetration required, the piling shall be jetted.

2.08 Cut-Off:

The tops of the piles shall be cut off, or driven down, to a straight line at the elevation indicated.

2.09 Cuts and Abrasions in Treated Timber:

All cuts in treated timber, and all abrasions, after having been carefully trimmed, shall be covered with 2 applications of a mixture of 60 per cent creosote oil and 40 per cent roofing pitch or brush coated with at least 2 applications of hot creosote oil and covered with hot roofing pitch.

MEASUREMENT AND PAYMENT

2.10 Method of Measurement:

Timber, concrete and steel sheet pile wall shall be measured by the square foot of wall complete in place and accepted.

2.11 Basis of Payment:

The number of square feet of timber, concrete and steel sheet pile wall, measured as provided above, shall be paid for at the contract unit price for "Untreated Timber Sheet Pile Wall," "Treated Timber Sheet Pile Wall," "Concrete Sheet Pile Wall" or "Steel Sheet Pile Wall," as the case may be, complete in place, which price and payment shall constitute full compensation for all materials including hardware and reinforcing steel, equipment, jetting if required, tools and labor necessary to complete the item.

Payment will be made under:

Item 5-2-1, Untreated Timber Sheet Pile Wall, per square foot.

Item 5-2-2, Treated Timber Sheet Pile Wall, per square foot.

Item 5-2-3, Concrete Sheet Pile Wall, per square foot.

Item 5-2-4, Steel Sheet Pile Wall, per square foot.

SECTION 3

PRESERVATIVE TREATMENTS FOR TIMBER

3.01 Description:

The preservative treatment of lumber, timber, posts and piling shall be in accordance with the requirements of this section. The type of treatment shall be one of the following:

Creosote oil
Creosote coal-tar solution
Pentachlorophenol-petroleum solution
Tanalith Wolman salts
Zinc Meta-arsenite
Chromated zinc chloride
Copperized chromated zinc chloride
Acid cupric chromate (Celcure or equal)

The kind of preservative treatment required for lumber and timber shall be as specified on the plans or in the special provisions.

The kind of preservative treatment required for posts shall be as specifically provided in Section 11, Part 5, Division II, unless otherwise indicated on the plans or in the special provisions.

The kind of preservative treatment required for piling shall be as specifically provided in Section 1, Part 5, Division II, unless otherwise indicated on the plans or in the special provisions.

MATERIALS

3.02 Preservatives:

The preservatives specified herein are not intended to be used interchangably, unless otherwise specifically provided in these specifications or on the plans or in the special provisions, but the kind of preservative to be used shall be adopted for its suitability to the conditions of exposure to which it will be subjected. Some of the conditions to be considered are: effect of marine borers, effect of termites, action of exposure to water and leeching of the preservative, effect of contact with the ground, painting requirements and cleanliness requirements. Experience records for the particular exposure intended shall be given consideration in selecting the treatment to be used.

All preservatives listed in these specifications shall conform to the applicable requirements of the current Federal Specifications for Wood Preservative; Recommended Treating Practice, TT-W-571.

CONSTRUCTION METHODS

3.03 Seasoning:

(a) Air Seasoning: Materials to be treated, preferably, shall be air-seasoned until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative. For air-seasoning the materials shall be stored as follows: Lumber shall be segregated according to size and each layer in the pile shall be separated by at least 1-inch strips with an air space of one inch or more between each 2 pieces of lumber in any layer; for large timbers, at least 2-inch strips shall be used to separate the layers. Alleys at least 3 feet wide shall be left between rows of stacks and the materials shall be at least 12 inches off the ground on concrete or treated timber sills. Piles shall be stored in like manner, placing as nearly as practical only one length in a stack, using at least 2-inch strips or saplings of equal size between each layer, and reversing all sticks in every other layer in order to keep the stack level. The space

under and between the rows of stacks shall be kept free at all times of wood, weeds or rubbish. The yard shall be so drained that no water can stand under the stacks or in their immediate vicinity.

(b) Steam Conditioning for Southern Pine: The material to be treated may be steamed in the cylinder at a temperature between 240°F and 259°F for not more than one hour for each inch of thickness for sawed timber and not more than one hour for each inch of diameter for posts and piles. The temperature shall be raised at a uniform rate so that at least one hour elapses between the attainment of 212°F and the attainment of 240°F.

(c) Oil Seasoning for Douglas Fir: Douglas Fir may be seasoned by boiling in oil under a vacuum until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative.

The material shall be boiled in creosote under a vacuum at temperatures which do not exceed 220°F for piling, and 200°F for sawed timber and lumber. A minimum vacuum of 20 inches shall be maintained during boiling. The seasoning period shall be maintained until condensation passing off from the timber is at the rate of approximately 1/10 of a pound per cubic foot of timber per hour, except that in timber to be treated with water-borne salts, the rate of condensation passing off from the timber shall be approximately 1/6 of a pound per cubic foot of timber per hour.

(d) Timbers, etc., to be treated with acid cupric chromate, either by pressure or by the natural vacuum process, shall be air-seasoned or kiln-dried to a moisture content not exceeding 20 per cent prior to treatment.

3.04 Preparation for Treatment:

Each cylinder charge shall consist of pieces approximately equal in size and moisture and sapwood content, into which approximately equal quantities of preserving fluid can be injected. Pieces shall be so separated as to insure contact of steam and preservatives with all surfaces.

So far as practicable, all adzing, boring, chamfering, framing, gaining, mortising, surfacing, etc., shall be done prior to treatment.

All Douglas Fir whose least dimension is 2½ inches or over, shall be incised in a suitable power-driven machine.

Lumber having a thickness of of 2½" and over shall be incised on all 4 sides. The spacing and shape of the cutting teeth and the method of incising shall be such as to produce a uniform penetration. The minimum depth of the incisions shall be in accordance with the following:

Thickness of Piece	Depth of Incision
2½" and less	No incising
3"	7/16"
4"	1/2"
8"	9/16"
10"	5/8"
12"	3/4"
Intermediate sizes in proportion.	

3.05 Treatments:

(a) General: Unless otherwise provided on the plans or in the special provisions, all materials shall be treated in accordance with A.W.P.A. Specifications, except as modified or supplemented by these specifications.

(b) Amount of Preservative: The net retention in any charge shall be not less than 90 per cent of the quantity of preservative that may be specified; but the average retention by the material treated under the contract and the average retention of any 5 consecutive charges shall be at least 100 per cent of the quantity specified. Unless otherwise specifically provided on the plans or in the proposal, the minimum amount of preservative retained shall be as follows:

(1) Creosote, Creosote Coal-Tar Solution or Pentachlorophenol-Petroleum Solution Treatment:

Material	Min. Net Retention of Preservative per cu. ft. of Wood
Southern Pine Timber	16 lbs. full cell
Douglas Fir Timber	12 lbs. full cell
Douglas Fir Piles	12 lbs. full cell
Southern Yellow Pine Piles	16 lbs. full cell
Southern Yellow Pine Piles for use in coastal waters (to be specified on plans or in proposal)	20 lbs. full cell
Fence and Gate Posts	5 lbs. full cell

Note: Creosote and Creosote coal-tar solutions shall not be used for treatment of materials which the plans require to be painted. Pentachlorophenol-petroleum solution may be used where painting is required, when permitted on the plans, however, the minimum net retention of preservative per cubic foot of wood shall be reduced to 8 pounds full cell.

(2) Salts Treatment:

	Pounds Dry Salts per cu. ft.	
	Unpainted Timbers	Painted Timbers
Tanalith Wolman salts	⅜	¼
Zinc Meta-arsenite	⅜	¼
Chromated zinc chloride	¾	½
Copperized CZC	¾	½
Acid cupric chromate	¾	½

Note: After treatment and before shipment, timber which is to be painted shall be kiln-dried or air-seasoned for a minimum of 30 days.

Timbers treated with acid cupric chromate may be treated by either the vacuum pressure process or by the natural vacuum process.

(c) Temperature of Preservatives: The temperature of preservatives during the entire pressure period shall conform to A.W.P.A. Specifications except as follows:

The temperature of the preservative during the entire pressure period of a pentachlorophenol-petroleum treatment shall not exceed 210°F.

(d) Penetration: The depth of penetration and the percentage of sapwood to be impregnated shall be in accordance with A.W.P.A. Specifications.

The engineer reserves the right to reject any material which when tested shows insufficient penetration of preservatives.

(e) Tests: Testing of preservatives and treated materials shall be conducted in accordance with A.W.P.A. Specifications.

(f) Treatment of Cuts, Abrasions and Bolt Holes:

(1) Creosoted Timbers: Cuts, abrasions and bolt holes in creosoted timbers shall be treated as provided in Articles 8.14 and 8.15, Part 4, Division II.

(2) Treated Piles: Cuts, abrasions and bolt holes in treated piles shall be treated as provided in the paragraph "Storage and Handling" of Article 1.10(c), Part 5, Division II.

(3) Salts Treated and Pentachlorophenol Treated Timbers: Cuts, abrasions and bolt holes in salts treated and pentachlorophenol treated timbers shall receive a drenching brush coat of a full strength solution of the type of treatment specified.

MEASUREMENT AND PAYMENT

3.06 Method of Measurement:

No measurement will be made for preservative treatment of timber except as provided under the various items requiring the use of preservative treatment.

3.07 Basis of Payment:

Payment for the preservative treatment of timber and piling will be made as provided for in the various contract items for treated materials.

SECTION 4

PAINTING

4.01 Description:

The painting of all items specified shall include the preparation of surfaces, the application, protection and drying of the paint coatings, and the supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work.

The terms used in these specifications shall be the standard definitions adopted by the A.S.T.M. and/or the A.A.S.H.O. The gallon used is the United States gallon containing 231 cubic inches.

The paint schedule for the various types of structures shall be as follows:

(a) Metal Surfaces in Steel and Concrete Structures: It is the intent of these specifications that all metal surfaces, whether classified as structural steel, machinery,

power plant, or otherwise, shall be painted unless otherwise stipulated or unless painting would interfere with the proper operation of the part.

Metal surfaces, including all unfinished surfaces of machinery parts, unless otherwise provided on the plans or in the special provisions, shall be painted with 4 coats of paint as follows:

1. Shop Coat—Red lead paint.
2. First Field Coat—Red lead paint tinted with one ounce of lampblack, paste form, to one gallon of finished paint; lampblack to be incorporated by manufacturer.
3. Second Field Coat—Red lead paint.
4. Third Field Coat—Aluminum paint.

Metal surfaces of stock items, such as gear reducers, electric motors, gasoline engines, and the like, which are ordinarily painted by the manufacturer, shall receive only the 3 field coats of paint specified above.

Galvanized metal surfaces, including galvanized electrical conduit, shall be painted 2 field coats of aluminum paint.

Control desks and switchboards shall be painted as described elsewhere. Equipment mounted on the control desks and switchboards is not to be painted unless required elsewhere.

(b) Timber Structures: When specified on the contract drawings, timber handrails of bridges and other timber structures, shall be painted with 3 coats of paint as follows:

1. First Coat—White lead paint.
2. Second Coat—White lead paint.
3. Third Coat—White lead paint.

(c) Guard Rails: Rails, and where specified, posts, shall be painted with 2 coats of paint as follows:

1. First Coat—White lead paint.
2. Second Coat—White lead paint.

(d) Blast Plates: Blast plates and hangers shall be painted on all surfaces with 3 coats of paint as follows:

1. Shop Coat—Red lead and oil.
2. First Field Coat—Graphite.
3. Second Field Coat—Bituminous paint.

(e) Traffic Stripes: The type of stripe required, the number of coats, width of stripe, and locations where required shall be as specified on the plans.

MATERIALS

4.02 Red Lead Paint:

Red lead paint shall conform to the requirements of the Specifications for Red Lead Ready-Mixed Paint, A.A.S.H.O. Designation: M 72, Type II.

4.03 White Lead Paint:

White lead paint shall conform to the requirements of the Specifications for White and Tinted Ready-Mixed Paint, A.A.S.H.O. Designation: M 70.

4.04 Aluminum Paint:

Aluminum paint shall conform to the requirements of the Specifications for Aluminum Paint, A.A.S.H.O. Designation: M 69.

4.05 Graphite Paint:

(a) Composition: This paint shall be made to meet the following requirements:

	Min.	Max.
Pigment, per cent	30.0	35.0
Vehicle, per cent	65.0	70.0

(b) Pigment: Graphite, Dry Pigment: The dry pigment shall be a pure amorphous and silicate rock to which may be added a small percentage of carbon black, iron oxide, or other oxides needed to secure a desired tint or color. The pigment shall be so ground that it will all pass a 200-mesh sieve, and contain not more than 3 per cent of material retained on a 325-mesh sieve. The prepared pigment must contain not less than 35 per cent nor more than 50 per cent of graphite in the form of graphite carbon.

(c) Vehicle: Vehicles for use in making graphite paint shall be composed of:

	Min.	Max.
Boiled Linseed Oil, per cent	88.0	92.0
Drier, per cent	5.0	6.0
Turpentine and volatile matter, per cent	3.0	6.0

The above components shall conform to the following requirements:

1. Boiled Linseed Oil: This material shall meet the requirements of the Specifications for Boiled Linseed Oil, A.A.S.H.O. Designation: M 126.

2. Drier: This material shall meet the requirements of the Federal Specifications for Drier, TT-D-651A.

3. Turpentine: This material shall meet the requirements of the Specifications for Spirits of Turpentine, A.A.S.H.O. Designation: M 127.

(d) Properties of Finished Paint: The resulting paint when mixed in the proportions given above and brushed on a smooth vertical metal surface shall dry hard and elastic without running, streaking or sagging.

4.06 Bituminous Paint (Blast Plate):

(a) Composition: This paint shall be made to meet the following requirements:

	Min.	Max.
Water (by evaporation at 212°F), per cent	45.0	50.0
Inert Mineral Ash, per cent	5.5	6.5
Bitumen (by differences), per cent	44.0	49.0

(b) Inert Mineral Ash: Type A—Lead Type: The ash must not contain less than 100 per cent lead.

Type B—Lead Free: The ash must contain no lead.

Action with Linseed Oil: Shall mix with linseed oil (1:19) without curdling.

Drying Properties: A mixture with linseed oil (1:19) shall dry within 8 hours.

The method of test shall be in accordance with Gardiner's Laboratory Manual, Standard Methods Fifth Edition, Institute of Paint and Varnish Research, Chapter 26—Page 614.

(c) Bitumen:

1. The bitumen shall be a pure, highly adhesive asphalt dispersed in water and, after drying, shall be incapable of becoming colloidal, dissolving, swelling, softening or gelatenizing in water.

2. Asphalt emulsions in which soap or clay is used as a dispersing agent are not acceptable under this specification. The use of hydrated lime or asphaltic solvents in the preparation will not be acceptable.

3. The dispersion shall be capable of sustaining, without clotting, dilution with water and shall not coagulate on additions of acids, alkalis or saline solutions.

4. The emulsion when spread upon a glass or steel plate in film thickness of approximately 1/16 inch and allowed to dry, shall not crack or check. It shall adhere to the plate so that it cannot be readily detached or stripped therefrom.

5. Any material shall be rejected which, when coated on glass or steel, to a thickness of 1/16 inch to 1/8 inch and allowed to dry for 48 hours in air at room temperature, shall thereafter, on continuous immersion in water and in a 5 per cent solution of sodium chloride (common salt) each for a period of 30 days, fail to retain its bond to the surface and its tenacity of body.

6. The emulsion shall be of heavy painting consistency, and such as may be applied by brush or spray.

7. Any sedimentation of emulsion solids occurring shall be of such character as to permit of ready redistribution by manual agitation to give a homogeneous product.

4.07 Foliage Green Bridge Paint:

This paint shall conform to the requirements of the Specifications for Foliage Green Bridge Paint, A.A.S.H.O. Designation: M 57.

4.08 Black Bridge Paint:

This paint shall conform to the requirements of the Specifications for Black Bridge Paint, A.A.S.H.O. Designation: M 68.

4.09 Zinc Chromate-Iron Oxide Ready-Mixed Paint:

This paint shall conform to the requirements of the Specifications for Zinc Chromate-Iron Oxide Ready-Mixed Paint, A.A.S.H.O. Designation: M 142.

4.10 Lampblack:

This material shall conform to the requirements of the Specifications for Lampblack, A.S.T.M. Designation: D 209.

4.11 White and Yellow Traffic Stripe Paint:

(a) Composition: These paints shall be made to meet the following requirements:

	Min.	Max.
Pigment, by weight, per cent	55	58
Vehicle, by weight, per cent	42	45

(b) Pigments: Pigments for white and yellow traffic stripe paints shall meet the following requirements:

	White	Yellow
Zinc Oxide, by weight, per cent	5	5
Chrome Yellow, by weight, per cent	.....	70
Asbestine, by weight, per cent	25	25
Lithopone, by weight, per cent	55	.....
Titanium Magnesium, by weight, per cent	15	.....

1. Zinc Oxide (Lead Free): Zinc oxide pigment and paste shall comply with the requirements of the Specifications for Zinc Oxide, A.S.T.M. Designation: D 79.

2. Chrome Yellow: Chrome yellow pigment and paste shall comply with the requirements of the Specifications for Chrome Yellow and Chrome Orange, A.S.T.M. Designation: D 211.

3. Asbestine: Asbestine (Magnesium Silicate) shall be finely ground, free from grit, adulterants or impurities other than silicate of iron, alumina, lime and man-

ganese. It shall show under a microscope the characteristic chrystalline structure of magnesium silicate.

4. Lithopone: Lithopone pigment shall comply with the requirements of the Specifications for Zinc Sulfide Pigments, A.S.T.M. Designation: D 477.

5. Titanium Magnesium: Titanium magnesium pigment shall comply with the requirements of the Specifications for Titanium Dioxide Pigments, A.S.T.M. Designation: D 476.

(c) Vehicle: Vehicles for white and yellow traffic stripe paints shall be composed of the following:

Non-Volatile Vehicle, by weight, per cent	45
Volatile Vehicle, by weight, per cent	55

1. Non-Volatile Vehicle: Non-volatile vehicle shall have the following composition:

Light Synthetic Resin of approved brand, by weight, per cent	45
Driers, concentrated cobalt type, by weight, per cent	5
Refined Tung Oil, by weight, per cent	50

2. Volatile Vehicle: Volatile vehicle shall have the following composition:

Naphtha, by weight, per cent	75
Benzol, by weight, per cent	25

(d) Manufacture of White and Yellow Traffic Stripe Paint: The finished paint shall be manufactured by an approved process. All pigments, after proper mixing, shall be thoroughly ground in the vehicle before reduction unless otherwise specified. The equipment for mixing and grinding shall be clean, modern and in good condition and subject to the approval of the engineer. As containers are being filled, the paint shall be screened to remove any coarse particles, skins, etc.

(e) Properties of Finished Paint: The paint shall dry to an elastic adherent finish that will not turn dark in sunlight or show appreciable discoloration with age. The

paint shall further permit ease and uniformity of application. The paint shall additionally meet the following requirements:

1. Bleeding Test: There shall be no perceptible bleeding when painted over a bituminous surface.

A surface for testing bleeding properties of the paint shall be prepared in the following manner:

Asphaltic mastic panels for testing the bleeding properties of the paint shall be composed of 9.5 to 12.5 per cent asphalt (50 to 60 penetration steam refined) and 87.5 to 90.5 per cent aggregate. The sieve analysis of the aggregate shall be 10 to 40 per cent passing No. 10 sieve and retained on a No. 40 sieve; 20 to 48 per cent passing a No. 40 sieve and retained on a No. 80 sieve; 12 to 36 per cent passing a No. 80 sieve and retained on a No. 200 sieve; 10 to 18 per cent passing a No. 200 sieve.

The mastic shall be heated to a temperature at which it will mold readily and then compressed into 3 inch by 6½ inch test panels. The panels shall be exposed out of doors in a horizontal position, directly to the weather, for not less than 2 weeks to cure and age. They shall then be allowed to dry and condition indoors for not less than 48 hours at 77°F. The paint shall be brushed on the exposed surface of the bituminous mastic panel with a 2½ inch brush using 2 strokes of the brush in one direction only. The paint film shall be as thin as possible, but completely hiding the bituminous surface. The paint coat shall be allowed to dry for 24 hours at 77°F and then examined.

Note: The bituminous mastic panels may be prepared in advance and held ready for use.

2. Water Resistance: One coat of the paint applied on a glass surface shall be allowed to air dry at room temperature (70-80°F) for 72 hours, then immersed in distilled water at room temperature for 18 hours, allowed to dry for 2 hours and examined. The immersed film shall show good adhesion to the surface, and shall show no deterioration other than a slight loss of gloss.

One coat of the paint applied on a concrete surface shall be allowed to air dry at room temperature for 72 hours, then immersed in distilled water at room temperature for 18 hours. When the wet paint surface is rubbed with a finger no appreciable amount of the paint film shall be rubbed off.

3. Elasticity: A coat of the finished paint when flowed on a clean 30-gage tin plate panel and allowed to dry in a vertical position for 15 minutes, then baked in a forced air-drying oven at 194-212°F for 5 hours, when bent double over a ⅛" rod, must not crack or flake on bending and/or straightening.

4. Consistency: The viscosity of the paint when measured at 77°F shall be not less than 75 K.U. or more than 90 K.U. (Method of Test for Consistency of Exterior House Paints and Enamel Type Paints, A.S.T.M. Designation: D 562).

5. Wearing Qualities: The paint shall give a satisfactory wear test, both in the laboratory and under actual service conditions, equal to the sample accepted by the Department's laboratory.

6. Color: White Traffic Stripe Paint: The paint shall dry to a pure intense white and furnish the maximum amount of opacity and visibility under both daylight and artificial light. It shall not discolor on exposure to weather or traffic and shall not show appreciable discoloration through staining during its service life on either concrete or bituminous surfaces.

Yellow Traffic Stripe Paint: The paint shall dry to furnish the maximum amount of opacity and visibility under both daylight and artificial light. It shall not discolor on exposure to weather or traffic and shall not show appreciable discoloration through staining during its service life on either concrete or bituminous surfaces. The yellow shall match the standard shade within the green and red tolerance limits when compared with standard color chips for highway signs obtainable from the Bureau of Public Roads, Washington, D. C.

7. Drying: The paint shall dry so there will be no pickup under traffic within 20 minutes after application on the road and shall dry free from tackiness within one hour after application (Method of Test for Dry to No-Pick-Up Time of Traffic Paint, A.S.T.M. Designation: D 711).

8. Storage: The paint shall not cake, "liver," thicken, curdle, gel or show any other objectionable properties after long periods of storage.

(f) Glass Beads for Use with White and Yellow Traffic Stripe Paints: Glass beads for use in luminous traffic stripes

shall consist of clean, dry, colorless, transparent spheres, made from optical glass.

The beads shall conform to the following grading:

Sieve No. U. S. Standard	Total Per Cent by Weight Passing Each Sieve
10	100
20	80–100
60	0–20
100	0–5
200	0

Shape: Not more than 30 per cent of the beads shall be ovate in shape or fused spheroids.

Character: The glass beads shall be of such character as to permit their embedment in pigmented binder or paint leaving their upper surfaces exposed to permit the retracting and reflecting of light rays.

CONSTRUCTION METHODS

4.12 General Requirements:

(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.

Glass beads for use in luminous traffic stripes shall be delivered in 100 pound moisture proof containers.

(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, and number of gallons.

Each glass bead container shall bear a label with the following information thereon: Name and address of the manufacturer, trade name or trade mark and number of pounds.

(c) Analysis: Paint: A one quart sample shall be taken at random from any or all deliveries.

Glass Beads: A 2-pound sample shall be taken at random from any or all deliveries.

Acceptance or rejection of shipments of paint and/or glass beads will be based on the analyses of these samples. The contractor should therefore secure necessary paint

and/or glass beads in ample time so that no delay to the work will be caused by the time necessarily used in testing for which 21 days should be allowed from the time the sample is collected by the inspector.

(d) Mixing of Paint: All paint shall be mixed thoroughly before applying and during application shall be stirred frequently so that the pigments are kept in suspension and the proper consistency maintained.

When glass beads are to be used with white or yellow traffic stripe paint to form a luminous traffic stripe, they shall be furnished in the proportion of 6 pounds of glass beads to one gallon of paint. The paint binder and glass beads shall be mixed in accordance with the manufacturer's directions.

(e) Weather Conditions: Paint shall not be applied when the atmospheric temperature is below 50°F, or when the air is misty, or when in the opinion of the engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces. Material painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit its exposure. Painting shall not be done when the surface is hot enough to cause the paint to blister and produce a porous paint film. If it is necessary in cool weather to thin the paint on account of congealing, this shall be done only by heating.

(f) Protection of Public and Work: In conducting painting operations on bridges and other structures, the contractor shall protect pedestrain, vehicular and other traffic upon or underneath the structure and also all portions of bridge superstucture and substructure against damage or disfigurement by splatters, splashes and smirches of paint or paint materials.

4.13 Painting of Metal Surfaces:

(a) Cleaning Metal: Surfaces of metal to be painted shall be cleaned thoroughly, removing rust, loose mill scale, dirt, oil or grease, and other foreign substances. The removal of rust, scale and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle brushes shall be used for removing loose dirt.

(b) Application: Painting shall be done in a neat and workmanlike manner. Paint for shop and field coats may be applied with hand brushes or by spraying or by a combination of these 2 methods of application. However, by either 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 engineer consider the results of spraying to be unsatisfactory.

Brushing: 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.

Spraying: Power spraying equipment shall apply the paint in a fine even spray without the addition of any thinner. In cool weather, the paint may be warmed to reduce the viscosity for use. Such warming shall be accomplished by heating the paint containers in water or by placing them on steam radiators. Paint when applied with spray equipment shall immediately be followed by hand brushing when necessary to secure uniform coverage and to eliminate airholes, blistering, splotches and/or wrinkling.

Inaccessible Surfaces: On all surfaces which are inaccessible for paint brushes, the paint shall be applied by spraying or with sheepskin daubers to insure thorough covering.

Galvanized Surfaces: Before painting weatherized galvanized surfaces they shall be treated as follows: In one gallon of soft water dissolve 2 ounces of each of copper chloride, copper nitrate and sal ammoniac, then add 2 ounces of commercial muriatic acid. This should be done in an earthen or glass vessel, never in tin or other metal receptacle. Apply the solution with a wide flat brush to the galvanized surface. Upon application, the surface will assume a dark, almost black color, which on drying becomes a grayish film. When dry, the surface shall then be washed with clear water.

(c) General: Not less than 72 hours shall elapse between coats of paint under normal weather conditions.

The contractor shall take all necessary precaution to prevent discoloration of concrete or other surfaces by the painting operation.

4.14 Shop Painting:

(a) Surfaces to be Painted: When fabrication is complete and the work has been accepted, surfaces not painted before assembling, except surfaces to be in contact after erection, shall be painted one coat.

(b) Erection Marks: Erection marks shall be painted on painted surfaces.

(c) Loading: Material shall not be loaded for shipment until the paint is dry.

(d) Contact and Inaccessible Surfaces: Surfaces to be riveted in contact either in the shop or field shall not be painted. Surfaces not in contact but which will be inaccessible after assembly or erection shall be painted 3 coats.

(e) Machine Finished Surfaces: With the exception of abutting chord and column splices and column and truss shoe bases, machine-finished surfaces shall be coated as soon as practicable after being accepted and before removal from the shop, with a hot mixture of white lead and tallow. Surfaces of iron and steel castings, machine-finished for the sole purpose of removing scales, fins, blisters or other surface deformations, shall be given the shop coat of paint.

The composition used for coating machine-finished surfaces shall be mixed in the following proportions: 4 pounds tallow, 2 pounds white lead and one quart linseed oil.

4.15 Field Painting:

The final coat of field paint shall not 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 of all concrete materials.

As soon as the field cleaning has been done to the satisfaction of the inspector, the heads of field rivets and bolts, and any surfaces from which the shop coat of paint has been worn off or has become otherwise 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 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 with red lead paste before the second field coat is applied.

All pins and pin holes shall be carefully cleaned of the shop coat of tallow and white lead, and of rust and dirt, and given before erection, a substantial coat of graphite and tallow in proportions satisfactory to the engineer.

In the application of aluminum paint by brushing, the finish strokes shall generally be in the same direction.

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 bituminous 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 45 degrees.

If, in the opinion of the engineer, 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 bridge 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.

4.16 Painting of Timber and Other Surfaces:

Parts of timber structures which are to be painted shall be designated on the plans or in the special provisions.

Metal parts, except hardware, shall be given one coat of shop paint and, after erection, the 3 coats of field paint, unless otherwise provided.

The color of the various coats of paint applied to timber structures, guard rails, etc., shall be of shades sufficiently different to permit detection of incomplete application.

4.17 Painting Traffic Stripes:

The color, location and width of traffic stripes shall be as shown on the plans.

The white or yellow traffic stripe paint, as the case may be, shall be applied on the concrete or bituminous surface as follows:

In order to produce the desired results, the contractor shall provide the necessary approved equipment which in

general will consist of a set of parallel form plates or angles of ¼ to 5/16 inch in thickness and suspended from a bridge or carrier mounted on wheels or supported on the pavement proper. The forms or guides shall be adjustable so that they may be raised or lowered. They shall be at least 6 feet long and spaced to obtain the widths required by the plans. The bottom edge of the angles shall be bevelled to a 45 degree angle with the inside face of the plates.

The traffic paint shall be applied in an approved manner so as to form stripes of the required widths, true to line and straight of edge.

MEASUREMENT AND PAYMENT

4.18 Method of Measurement:

No measurements will be made for painting, unless specifically provided for in the contract.

4.19 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 properly complete, in accordance with these specifications, all painting required.

SECTION 5

STEEL RAIL CATTLE GUARDS

5.01 Description:

This item shall consist of the construction of welded steel rail cattle guards at the locations and conforming to the details shown on the plans, and in accordance with these specifications.

It is the intent of these specifications to secure portable steel rail cattle guards that can be set in place on the reinforced concrete walls or footings. The plans show types of crossings that are acceptable to the Department. Cattle guards of other types may be furnished if prior

approval is obtained from the Department. If bids are submitted on some other type, it will be necessary to include, with the bid, manufacturer's drawings and specifications for the type the bidder contemplates furnishing for approval by the Department's engineers.

MATERIALS

5.02 Steel Rail:

Rail shall be of carbon steel and the weight of rail used in the various types of cattle guards shall be as follows:

Type A, B or C, Deck Rails	42 to 45 pound
Type A, B or C, Stringer Rails	56 to 70 pound
Type D, Deck and Stringer Rails	25 pound

5.03 Pipe Wings:

Pipe wings shall be of standard strength black or galvanized iron pipe, 2 inch inside diameter. If black pipe is furnished it shall receive, in the shop, one coat of primer and one coat aluminum paint. Paint and its application shall conform to the applicable requirements of Section 4, Part 5, Division II. Galvanized pipe will not require painting.

5.04 Concrete:

Concrete for bottom slabs, walls and footings shall be Class A meeting the applicable requirements of Section 5, Part 4, Division II.

5.05 Reinforcing Steel:

Reinforcing steel shall be deformed bars meeting the requirements of Article 6.02, Part 4, Division II.

5.06 Treated Timber:

Treated timber shall be creosoted pine (16 pound treatment) or Douglas fir (12 pound treatment) of the size and dimensions shown on the plans. Timbers shall be Dense No. 1 Structural having a unit working stress of not less than 1600f, and in other respects shall conform to the applicable requirements of Section 8, Part 4, Division II.

Timbers shall be treated in accordance with the applicable requirements of Section 3, Part 5, Division II.

5.07 Hardware:

All hardware shall be standard quality of the size and dimensions recommended by the fabricator of cattle guards and acceptable to the engineer.

CONSTRUCTION METHODS

5.08 Excavation and Backfill:

A trench of sufficient width shall be excavated (if required) to the line and grade indicated on the plans or directed by the engineer. 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 8 inches loose thickness and each layer shall be thoroughly compacted with approved mechanical tampers.

5.09 Reinforced Concrete:

All concrete shall be placed in accordance with the applicable requirements of Section 5, Part 4, Division II. Reinforcing steel shall be placed in accordance with the plans and the applicable requirements of Section 6, Part 4, Division II, and securely fastened in an approved manner so as not to be displaced during the placing of the concrete.

5.10 Placing Timbers:

When timbers are required in side walls, they shall be placed as shown on the plans.

5.11 Rails and Pipe Wings:

Rails shall be placed in accordance with the details shown on the plans, welded together in an approved manner, and the completed guard rail shall be substantial in every respect.

Pipe wings shall be of the hinged type constructed in accordance with the plan details.

When Type A guard rails are to be furnished, the two sections shall be equipped with plates welded to the rails, and sufficient bolts to fasten the two sections together, all as shown on the plans.

The guard rails with pipe wings shall be completely assembled in the shop and shall be delivered to the site of work ready for placement on the concrete walls or footings.

MEASUREMENT AND PAYMENT

5.12 Method of Measurement:

Steel rail cattle guards, of the type shown on the plans or in the proposal, will be measured, complete in place and accepted, and each completed cattle guard will be counted.

5.13 Basis of Payment:

The number of cattle guards completed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Steel Rail Cattle Guards," which price and payment shall constitute full compensation for furnishing and fabricating the cattle guards including pipe wings; for furnishing and placing reinforced concrete; for furnishing and placing treated timbers if required; and for all materials, labor, equipment, tools and incidentals and the performance of all work necessary to complete the item.

Fence and gates, including posts, as shown on the plans, will be measured and paid for under other items.

Payment will be made under:

Item 5-5-1, Steel Rail Cattle Guards, Type A (With Concrete Walls and Bottom Slab), per each.

Item 5-5-2, Steel Rail Cattle Guard, Type B (With Concrete Walls and Bottom Slab), per each.

Item 5-5-3, Steel Rail Cattle Guards, Type C (With Concrete Walls and Bottom Slab), per each.

Item 5-5-4, Steel Rail Cattle Guards, Type C (With Timber Walls and Concrete Footings) (Without Bottom Slab), per each.

Item 5-5-5, Steel Rail Cattle Guards, Type D (With Concrete Walls and Bottom Slab), per each.

Item 5-5-6, Steel Rail Cattle Guards, Type D (With Timber Walls and Concrete Footings) (Without Bottom Slab), per each.

SECTION 6

WATERPROOFING

6.01 Description:

This item shall consist of waterproofing of concrete surfaces by the membrane method in accordance with the following specifications. Surfaces to be waterproofed shall be those indicated on the plans or as directed by the engineer.

MATERIALS

6.02 Asphalt:

Waterproofing asphalt shall conform to the Specifications for Asphalt for Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 115.

Type A is for use above ground and Type B is for use below ground. Unless otherwise specified, Type B shall be used.

6.03 Primer:

(a) Primer for use with asphalt in waterproofing shall conform to the Specifications for Primer for Use with Asphalt in Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 116.

(b) Primer for use with coal-tar pitch in waterproofing shall conform to the Specifications for Creosote for Priming Coat with Coal-Tar Pitch in Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 121.

6.04 Pitch:

Waterproofing pitch shall conform to the Specifications for Coal-Tar Pitch for Roofing, Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 118.

Type B shall be furnished unless otherwise specified.

6.05 Fabric:

The waterproofing fabric shall conform to the Specifications for Woven Cotton Fabrics Saturated With Bituminous Substances for Use in Waterproofing, A.A.S.H.O. Designation: M 117.

6.06 Tar for Absorptive Treatment:

Tar for absorptive treatment shall be a liquid water-gas tar which conforms to the following requirements:

Specific Gravity, 77°/77°F	1.030 to 1.100
Specific Viscosity at 104°F (Engler), not more than	3.0
Total Distillate, by weight, per cent to 572°F, not more than	50.0
Bitumen (soluble in carbon disulphide), not less than, per cent	98.0
Water, not more than, per cent	3.0

6.07 Tar Seal Coat:

Tar seal coat shall conform to the Specifications for Tar for Use in Road Construction, A.A.S.H.O. Designation: M 52, Grade RTCB–5.

6.08 Joint Filler:

(a) Filler for use in horizontal joints in waterproofing work shall be straight refined oil asphalt conforming to the following requirements:

Flash Point:	Not less than 450°F.
Softening Point:	120°F to 130°F.
Penetration:	At 32°F, 200g., 1 min., not less than 15.
	At 77°F, 100g., 5 sec., 50 to 60.
	At 115°F, 50g., 5 sec., not more than 300.
Loss on heating:	At 325°F, 50g., 5 hrs., not more than 0.5 per cent.
Ductility:	At 77°F, 5cm. per min., not less than 85.
Total Bitumen (soluble in CS_2):	Not less than 99.5 per cent.

(b) Filler for use in vertical joints in waterproofing work shall be an asphalt conforming to the requirements specified above for horizontal joint filler, to which has been added 20 per cent by weight of asbestos fiber. The incorporation of the asbestos fiber with the asphalt shall be done by the manufacturer to insure a uniform distribution of the fiber throughout the mix.

6.09 Sand for Mortar:

Sand for mortar shall conform to the Specifications for Mortar Sand, A.A.S.H.O. Designation: M 45.

CONSTRUCTION METHODS

6.10 General:

All surfaces which are to be waterproofed shall be reasonably smooth and free from projections or holes which might cause puncture of the membrane. The surface shall be dry, so as to prevent the formation of steam when the hot asphalt or tar is applied, and, immediately before the application of the waterproofing, the surface shall be thoroughly cleaned of dust and loose materials.

No waterproofing shall be done in wet weather, nor when the temperature is below 35°F, without special authorization from the engineer. Should the surface being waterproofed become temporarily damp, it shall be covered with a 2-inch layer of hot sand, which shall be allowed to remain in place from 1 to 2 hours, or long enough to produce a warm and surface-dried condition, after which the sand shall be swept back, uncovering sufficient surface for beginning work, and the operation repeated as the work progresses.

Asphalt shall be heated to a temperature between 300° and 350°F. Tar for hot application shall be heated to a temperature between 200° and 250°F, with frequent stirring to avoid local overheating. The heating kettles shall be equipped with thermometers.

In all cases, the waterproofing shall begin at the low point of the surface to be waterproofed, so that water will run over and not against or along the laps.

The first strip of fabric shall be of half width; the second shall be full width, lapped the full width of the first sheet; and the third and each succeeding strip shall be full width and lapped so that there will be 2 layers of fabric at all points with laps not less than 2 inches wide. All end laps shall be at least 12 inches.

Beginning at the low point of the surface to be waterproofed, a coating of primer shall be applied and allowed to dry before the first coat of asphalt is applied. The waterproofing shall then be applied as follows:

Beginning at the low point of the surface to be waterproofed, a section about 20 inches wide and the full length of the surface shall be mopped with the hot asphalt or tar, and there shall be rolled into it, immediately following the mopping, the first strip of fabric, of half width, which shall be carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This

strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used shall then be mopped with hot asphalt or tar, and a full width of the fabric shall be rolled into this, completely covering the first strip, and pressed into place as before. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt or tar and the third strip of fabric "shingled" on so as to lap the first strip not less than 2 inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 2 inches over the next to last strip. The entire surface shall then be given a final mopping of hot asphalt or tar.

The completed waterproofing shall be a firmly bonded membrane composed of 2 layers of fabric and 3 moppings of asphalt or tar, together with a coating of primer. Under no circumstances shall one layer of fabric touch another layer at any point or touch the surfaces, as there must be at least 3 complete moppings of hot asphalt or tar.

In all cases the mopping on concrete shall cover the surfaces so that no gray spots appear, and on cloth it shall be sufficiently heavy to completely conceal the weave. On horizontal surfaces not less than 12 gallons of asphalt or tar shall be used for each 100 square feet of finished work, and on vertical surfaces not less than 15 gallons shall be used. The work shall be so regulated that, at the close of a day's work, all cloth that is laid shall have received the final mopping of asphalt or tar. Special care shall be taken at all laps to see that they are thoroughly sealed down.

At the edges of the membrane and at any points where it is punctured by such appurtenances as drains or pipes, suitable provisions shall be made to prevent water from getting between the waterproofing and the waterproofed surface.

All flashings at curbs and against girders, spandrel walls, etc., shall be done with separate sheets lapping the main membrane not less than 12 inches. Flashing shall be closely sealed either with a metal counterflashing or by embedding the upper edges of the flashing in a groove poured of joint filler.

Joints which are essentially open joints but which are not designed to provide for expansion shall first be caulked

with oakum and lead wool and then filled with hot joint filler.

Expansion joints, both horizontal and vertical, shall be provided with sheet copper or lead in "U" or "V" form in accordance with the details, and after the membrane has been placed shall be filled with hot joint filler. The membrane shall be carried continuously across all expansion joints.

At the ends of the structure the membrane shall be carried well down on the abutments and suitable provision made for all movement.

Care shall be taken to prevent injury to the finished membrane by the passage over it of men or wheelbarrows, or by throwing any material on it. Any damage which may occur shall be repaired by patching. Patches shall extend at least 12 inches beyond the outermost damaged portion and the second ply shall extend at least 3 inches beyond the first.

Over the waterproofing membrane, constructed as specified above, there shall be constructed a protection course which, unless otherwise specified or shown on the plans, shall be a 2-inch course of mortar in the proportion of one part Portland cement and 2 parts sand. This mortar course shall be reinforced between its top and bottom surfaces with wire netting of 6-inch mesh and No. 12 gage, or its equivalent. The top surface shall be troweled to a smooth, hard finish and, where required, true to grade.

The construction of the protection course shall follow the waterproofing so closely that the latter will not be exposed without protection for more than 24 hours.

MEASUREMENT AND PAYMENT

6.11 Method of Measurement:

Waterproofing completed and accepted will be measured by the square yard.

6.12 Basis of Payment:

The number of square yards of completed and accepted waterproofing, measured as provided above, shall be paid for at the contract unit price per square yard for "Waterproofing," which price and payment shall be

full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 5-6-1, Waterproofing, per square yard.

SECTION 7

DAMPPROOFING

7.01 Description:

This item shall consist of dampproofing concrete surfaces in accordance with these specifications at the location shown on the plans or directed by the engineer.

MATERIALS

7.02 Asphalt:

Dampproofing asphalt shall conform to the Specifications for Asphalt for Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 115.

Type A is for use above ground and Type B is for use below ground. Unless otherwise specified, Type B shall be used.

7.03 Primer:

Primer for use with asphalt in dampproofing shall conform to the Specifications for Primer for Use with Asphalt in Dampproofing and Waterproofing, A.A.S.H.O. Designation: M 116.

7.04 Tar for Absorptive Treatment:

Tar for absorptive treatment shall conform to the requirement of Article 6.06, Part 5, Division II.

7.05 Tar Seal Coat:

Tar seal coat shall conform to the Specifications for Tar for Use in Road Construction, A.A.S.H.O. Designation: M 52, Grade RTCB–5.

CONSTRUCTION METHODS

7.06 General:

After the concrete is cured in conformity with the requirements hereinbefore given in the specifications for "Concrete," Section 5, Part 4, Division II, the surfaces to be dampproofed shall be allowed to dry at least 10 days before the primer is applied. They shall then be brush or spray painted with 2 or more coats (as indicated on the plans or in the special provisions) of tar or asphalt for absorptive treatment. Below ground not less than 2 coats shall be applied, using ⅛ gallon per coat for each square yard of surface. On the well primed surface one application of tar or asphalt seal coat shall be applied by brush, using 1/10 gallon per square yard. The seal coat shall harden before any water or earth is allowed to come against it. No coat shall be applied when the concrete or the preceding coat is damp or at any time when in the opinion of the engineer the weather is unsuitable.

Care shall be taken to confine all paints to the area to be dampproofed and to prevent disfigurement of any other parts of the structure by dripping or spreading of the tar or asphalt.

MEASUREMENT AND PAYMENT

7.07 Method of Measurement:

Dampproofing completed and accepted will be measured by the square yard.

7.08 Basis of Payment:

The number of square yards of completed and accepted dampproofing, measured as provided above, shall be paid for at the contract unit price per square yard for "Dampproofing," which price and payment shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Item 5-7-1, Dampproofing, per square yard.

SECTION 8

MOVABLE BRIDGES

Movable Bridge Machinery
Power Plant
Operating House
Machinery Houses

8.01 Description:

These items shall consist of the furnishing, fabrication, and erection of swing, bascule, and vertical lift bridges, and of all appurtenances required for their operation such as movable bridge machinery, power plant, operating house, and machinery houses.

The requirements for fixed span bridges, as given in Division II, Part 4, "Structures," of these specifications, shall apply to movable bridges except as herein provided.

8.02 Silence of Specifications:

The apparent silence of the 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.

8.03 Objection to Specifications:

If the contractor has any objections to any features of the machinery or power equipment, as required by these specifications, he must state his objections immediately in writing to the engineer before any parts are manufactured; otherwise his objections will be ignored, if offered as an excuse for defective or broken machinery.

8.04 Guarantee of Machinery and Power Equipment:

All machinery and power equipment shall be satisfactory to the engineer, 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 manufacturers have varied from these specifications or from the special provisions without the engineer's writ-

ten permission to do so, and if such variation should, within the said one year, cause any breakdown or accident, the contractor will not only be required to repair the damage to the affected members, but will also be held pecuniarily responsible to the Department for all expense to the latter due to such failure.

8.05 Bond:

As a guarantee for the replacement of defective or broken parts as stated above, the contractor will be required to furnish satisfactory bond in full amount of the price bid for machinery 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 Louisiana Department of Highways prior to the payment of the final estimate.

8.06 Shop Drawings:

In addition to the shop drawings specified in Division II, Part 4, "Structures," of these specifications, 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 parts, and assembly layouts of all items he is to furnish. Certified dimension sheets of motors, brakes, generators, gasoline engines, limit switches, traffic gates, and all other such equipment shall be submitted 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. The project number, name of project, and parish shall be shown on each certified dimension sheet.

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 on 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 #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 operating house shall include a layout, to scale, showing the location of all apparatus in the house and description of doors, windows, and hardware.

The drawings for the counterweights shall show all dimensions, reinforcing, method of construction, and all necessary calculations.

A detailed list of all electrical equipment and devices, and all commercial machinery 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.

Two copies of each drawing and certified dimension sheet shall be submitted to the Bridge Design Engineer of the Department of Highways, in Baton Rouge, for checking, one of which will be returned with either approval or required revisions noted thereon. When changes on submitted drawings are requested by the engineer and the contractor makes additional changes, other than those expressly requested, he shall direct attention to them on the next copies of the drawings submitted by underscoring with colored crayons or other suitable means. For final approval, the contractor shall submit 9 copies of all drawings and certified dimension sheets.

No drawing shall be placed in the shop or work started thereon until it has been approved by the engineer. Such approval, however, shall not relieve the contractor of any responsibility placed upon him by his contract.

Shop drawings shall be 22 inches by 36 inches in size, and shall be made in ink on tracing cloth. The project number, name of project, and parish shall be shown on each drawing. After completion of the work, the original tracings, corrected to show all parts of the work as actually installed, shall be delivered to the Bridge Design Engineer of the Department of Highways in Baton Rouge. The final estimate will not be approved for payment until the original tracings have been delivered to the Bridge Design Engineer.

The contractor will be permitted to deliver reproductions on cloth, of a permanent type, from which legible prints may be made, of the original tracings, if he prefers. If the contractor elects to deliver reproductions on cloth, the original tracings may be made in any manner the contractor prefers, providing satisfactory reproduction on cloth can be made from the original tracings.

No additional payment will be made for these certified dimension sheets, tracings, and copies of tracings, the cost thereof shall be considered as included in the prices bid for the various items.

If any part of the work 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, providing that he notifies the Bridge Design Engineer that the work is to be performed exactly as shown on the design drawings, but the contractor shall be responsible for any dimensional errors which may be on the plans, and will not be relieved of any responsibility placed upon him by his contract.

8.07 Maintenance and Operation Instruction Booklets:

The contractor shall furnish 6 bound copies of a booklet, 8½" x 11" 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 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.

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.

8.08 Instructor and Instruction to Operators:

The contractor shall notify the engineer when the span, including the power plant 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 man, experienced in the operation of equipment of this character, for a period of 5 working days of 8 hours each to instruct the bridge operators in the complete and correct operation of the bridge. This 5 day period of instruction shall be just prior to final inspection. This provision shall also apply for manually operated movable bridges.

8.09 Tools and Maintenance Equipment to be Furnished by the Contractor:

The contractor shall furnish a set of tools and equipment as may be required for ordinary servicing and maintenance of the bridge. In the absence of further specific requirements this shall include a set of wrenches to fit the heads and nuts of all machinery bolts and grease guns and oiling equipment to fit all lubrication fittings.

MATERIALS

8.10 Metals:

Metals to be used in the manufacture of parts for movable bridges shall be as listed in Division IV, Design of Movable Bridges, of these specifications and as shown on the plans and further provided herein.

Unless otherwise specified, structural metals shall conform to the latest revision of the following A.S.T.M. Specifications:

Material	ASTM Specification
Structural steel	A-7, A-242, A-94, A-373, as specified
Cast steel	A-27, Grade 65-35
Forged steel	A-235, Class C1 or Class G as may be specified
Alloy steel forgings	A-237, Class A
Cold rolled steel	A-108
Bronze for center discs	B-22, Alloy A
Bronze for trunnion and similar bearings	B-22, Alloy B
Bronze for shaft and ordinary bearings	B-22, Alloy C
Bronze for gears, nuts transmitting motion and other parts involving stresses other than compression	B-22, Alloy D
Babbitt metal	B-23, Grade 3
Steel for center discs	A-235, Class G
Steel for keys	A-235, Class E
Bolts—machine or turned	A-307, Grade A
Cast iron	A-48, Class 30

8.11 Wire Rope and Attachments:

All wire ropes shall be of improved plow steel wire, uncoated.

All operating wire ropes shall be preformed wire rope.

All wire ropes unless otherwise specified shall be of 6 x 19 filler wire construction with hard fiber core. Each strand shall consist of 19 main wires and 6 filler wires, fabricated in one operation; 4 sizes of wires in each strand; 12 outer wires of one size, 6 filler wires of one size, 6 inner wires of one size and a core wire.

All wire ropes, unless otherwise specified, shall be Right Regular Lay, and the maximum length of rope lay shall be as follows:

Operating ropes	6¾ times nominal wire rope diameter
Counterweight ropes	7½ times nominal wire rope diameter

make the wires approximately parallel to the axis of the

The lay of the wires in the strands shall be such as to

wire rope where they would come in contact with a circular cylinder circumscribed on the wire rope.

All hard fiber cores shall be pre-lubricated by the cordage manufacturer. All component parts of the wire ropes, fiber cores, wires and strands shall be lubricated during fabrication with a lubricant containing a rust inhibitor, approved by the engineer.

The amount which the actual diameter of the wire rope differs from the nominal diameter, shall not be greater than the following:

Nominal Diam. Wire Rope	Undersize	Oversize
½″ to ¾″	0	1/32″
13/16″ to 1⅛″	0	3/64″
1 3/16″ to 1½″	0	1/16″
1 9/16″ to 2¼″	0	3/32″
2 5/16″ to 2½″	0	⅛″

The physical properties of the bright (uncoated) individual wires of the wire ropes, before fabrication in the wire rope, shall be as follows, with the exception of the filler wires, which latter may be made to the manufacturer's standards.

(a) The unit tensile strengths of the component wires shall be as follows:

Diam. Wires	Tensile Strength—p. s. .	
	Minimum	Maximum
.032—.060″	238,000	268,000
.061—.100″	230,000	260,000
.101—.140″	225,000	255,000
.141—.190″	218,000	248,000

(b) Test specimens from not less than 10% of the coils of the wires shall be subjected to a torsion test in which the distance between the jaws of the testing machine is 8″. The number of complete successive turns of 360° in one direction through which an 8″ length of wire can be twisted around its longitudinal axis without breaking or showing

signs of splitting or other defects shall not be less than the following, in terms of the wire diameter "d" in inches:

Diam. Wires	Minimum Torsions in 8″ length
.032—.060″	$\frac{2.3}{d}$
.061—.100″	$\frac{2.2}{d}$
.101—.140″	$\frac{2.1}{d}$
.141—.190″	$\frac{2.0}{d}$

(c) The total ultimate elongation of the wires measured on a 10″ gauge length, at the breaking load of the wire, shall not be less than the following:

Diam. Wires	Elongation
.032—.060″	1½%
.061—.100″	1¾%
.101—.140″	2%
.141—.190″	2¼%

The test specimens shall be at least 15″ long, and free from bends and kinks.

(d) The tolerance limits of like positioned wires in the strands of the wire rope shall not exceed the following values:

Diam. Wires	Total Variation
.032—.060″	.002″
.061—.100″	.0025″
.101—.140″	.003″
.141—.190″	.0035″

The minimum breaking strengths of bright (uncoated) wire ropes shall be in accordance with the following values:

Diam. Wire Rope	Minimum Breaking Strength—Lbs.	Diam. Wire Rope	Minimum Breaking Strength—Lbs.
½"	21,000	1⅝"	209,000
⅝"	33,000	1¾"	242,000
¾"	46,000	1⅞"	275,000
⅞"	63,000	2"	312,000
1"	81,000	2⅛"	349,000
1⅛"	103,000	2¼"	390,000
1¼"	126,000	2⅜"	432,000
1⅜"	151,000	2½"	476,000
1½"	179,000		

Should the breaking strength of the wire rope fall below the above values, 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 the wire rope and/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 2 joints in any one strand shall be made closer than 25 feet apart, except for filler wires.

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.

Counterweight ropes shall be prestressed and the prestressing load shall be 35% 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 to 35% and the maximum loadings shall be held on the wire rope for a period of 15 minutes each.

The length of each wire rope from center line of open socket pins or from the bearing of closed sockets shall be measured under a tension of 12% 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 length of these wire ropes shall not vary from the specified length by more than plus or minus .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 the current Specifications for Carbon Steel Forgings for General Industrial Use, A.S.T.M. Serial Designation A-235, Class C1, normalized. The socket shall be attached to the wire rope by using zinc of a quality not less than defined for Intermediate Grade in A.S.T.M. Serial Designation B-6 and the 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% of the listed breaking strength of same, shall not exceed ⅛ 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 per cent 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.

All tests shall be made in the presence of the engineer.

The manufacturer shall provide proper facilities for making the tests and shall make them at his expense.

If the physical properties of the rope or of 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 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 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 also reserves the right to test each wire rope at his expense after the sockets are attached, by a load equal to one-half of 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.

Unless otherwise specified, all wire ropes 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.

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.

CONSTRUCTION METHODS

8.12 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 as provided in Division II, Part 4, "Structures," of these specifications.

8.13 Manufacture and Fabrication of Machinery:

(a) Shop Practice: The manufacture of machinery parts shall be in accordance with the best practice of modern foundries and machine shops. The general manufacture of machined parts shall be in accordance with applicable standards of the American Standards Association for the various items required.

(b) Inspection: The contractor shall give the engineer ample notice before beginning the manufacture of any machinery item, so that inspection may be provided. The contractor shall furnish facilities for the inspection of material and workmanship and the inspectors shall be allowed free access to the necessary parts of the work.

(c) Tolerances (Plus and Minus) for Accurate Work: The allowance 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:

	A. S. A. Surface Finish
Loose Fit (Class 1), Large Allowance. This fit 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 pressures 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 with 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 table:

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)	Med. Force Fit (Class 7)	Heavy Force & Shrink (Class 8)
	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
	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
	(+)	(+)	(+)	(+)	(+)	(+)		(+)	(+)	(+)	(−)	(−)	(−)
1 1/16—1 3/16	30	90	15	43	10	26	0	10	4	6	3	6	11
1 3/16—1 3/8	30	90	16	44	10	28	0	10	4	6	3	6	13
1 3/8—1 5/8	30	90	18	48	12	30	0	12	5	7	4	8	15
1 5/8—1 7/8	40	100	20	52	13	33	0	12	5	7	4	9	18
1 7/8—2 1/8	40	100	22	54	14	34	0	13	5	8	5	10	20
2 1/8—2 3/8	40	100	24	58	15	35	0	13	5	8	6	11	23
2 3/8—2 3/4	50	110	26	62	17	39	0	13	5	8	6	13	25
2 3/4—3 1/4	50	130	29	67	19	43	0	15	6	9	8	15	30
3 1/4—3 3/4	60	140	32	72	21	45	0	15	6	9	9	18	35
3 3/4—4 1/4	60	140	35	77	23	49	0	16	6	10	10	20	40
4 1/4—4 3/4	70	150	38	80	25	51	0	17	7	10	11	23	45
4 3/4—5 1/2	70	150	41	85	26	54	0	17	7	10	13	25	50
5 1/2—6 1/2	80	180	46	94	30	60	0	18	7	11	15	30	60
6 1/2—7 1/2	90	190	51	101	33	63	0	19	8	11	18	35	70
7 1/2—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" 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	$0.0009\sqrt[3]{d^2}$		$0.0008\sqrt[3]{d}$	$0.0008\sqrt[3]{d}$
(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 of fit for Classes 5 to 8.

(e) Shafts, Trunnions and Journals: Shafts and trunnions shall be made with fillets where abrupt changes in section occur.

The journals of shafts and trunnions shall be polished to A.S.A. No. 8 surface finish after being machined. In 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 about ⅕ of the diameter of the shaft or trunnion.

(f) Couplings: The faces of flange couplings shall be planed to A.S.A. No. 125 surface finish, and holes bored in pairs.

(g) 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.

(h) Bushings: Bushings shall be bored to fit the shaft or journal to the tolerances specified by the engineer, and the shaft turned to fit.

The bearing shall be bored to fit the outside of the bushing.

The edges of oil grooves and bushings shall be rounded.

Babbitt metal shall be poured in the bearing in such a way that the thickness of the bushing after boring will be uniform.

(i) Bearings: The rubbing and bearing surfaces shall have an A.S.A. No. 16 surface finish and the joints between cap and base of bearings shall have an A.S.A. 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 called for in (o). 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.

(j) 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 cast or cut and finished, as specified by the engineer.

(k) 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.

(l) 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.

(m) Keys 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.

(n) Castings: Castings shall be cleaned and all fins and other irregularities removed so that they will have clean, smooth surfaces, suitable for this class of work. Castings which are to be attached to structural steel or other castings shall have their contact surface finished to A.S.A. 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 A.S.A. No. 2000 finish.

(o) Bolt Holes and Turned Bolts: Holes for unfinished bolts shall be drilled or reamed not more then $\frac{1}{16}$ inch larger in diameter than the bolts. The diameter of the shank of turned bolts shall be of such size as to make a Class 1 fit for the holed parts.

(p) 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.

(q) Brakes and Brake Linings: Brake shoes or bands shall be made so as to bear uniformly on the brake wheels. 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.

(r) Rack and Track: In swing bridges, track segments shall be finished on the top and at the ends to A.S.A. No. 250 surface finish. The center line shall be scribed on the surface.

The toothed segments forming the rack shall be fitted accurately. Particular care shall be taken to have the pitch of the teeth at the joints accurate. 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 A.S.A. No. 1000 surface finish. Surfaces which bear on masonry shall have A.S.A. No. 2000 surface finish.

(s) Pivot Pedestals: The disc seats shall be so finished as to insure a horizontal position of the span.

(t) Discs: Discs for pivot bearings shall be fitted accurately, finished to gage, and shall be ground accurately to the final finish. The sliding surfaces of steel and phosphor-bronze discs shall be polished to A.S.A. No. 8 surface finish. Disc centers shall be assembled, fitted accurately and match-marked.

(u) Balance Wheels: The periphery and faces of balance wheels shall be turned to A.S.A. No. 250 surface finish, the corners shall be rounded, and the center line of the balance wheels shall be scribed on the periphery. The hubs shall be bored accurately and faced on both ends.

(v) Planing Girders: In built track girders and segmental girders of rolling bascule bridges, the edges of the webs, side plates, and angles shall be so planed to A.S.A. No. 250 surface finish that full bearing on the track plate will be secured.

(w) Tread Plates and Track Segments: The contact surfaces of tread plates and track segments shall be planed to A.S.A. No. 250 surface finish so that full bearing on the tread plates will be secured.

(x) Oil or Grease Grooves in Trunnions: The oil or grease grooves in the surfaces of trunnions and similar large bearings shall be machine cut. Small inequalities may be removed by chipping and filing. The grooves shall be smooth, especially the rounded corners.

(y) 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 shop. If they are to be disassembled for shipment they shall be match-marked for field erection.

(z) 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 shall 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 a Class 8 fit on shaft or axle.

Both ends of hub shall be finished as specified by the engineer.

(aa) 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 templets 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 to place without injury to themselves, the bearings, the girders, or the columns.

(bb) 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, 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" smaller and reamed to size in the field after erection.

(cc) Protection of Machinery Parts During Shipment: All finished rubbing and bearing surfaces of machinery parts shall be given a protective coating before shipment. The bearing surfaces of trunnions and of heavy axles and shafts, in addition to the protective coating, shall be protected by wooden 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 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.

8.14 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 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 than 16 inches above the ground and free from conditions likely to produce corrosion of the wires or 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 Erection: The alignment and adjustment of machinery shall be done by skilled mechanics. Trunnion bearings and all important shaft bearings shall be set using piano wire or optical methods providing similar accuracy, to determine their correct adjustment.

Shims shall preferably be sheet copper or brass. The contractor shall have a supply of shims varying in size and thickness with a minimum thickness of $\frac{3}{1000}$ of an inch. Where necessary, shims shall be used for aligning and adjusting machinery to its proper place preparatory to securing it rigidly in position by bolts or other fastenings. To prevent localization of stresses in the machinery parts, the shims shall not be less in dimensions than the bearing area shimmed.

All minor pockets and depressions formed as a result of erection and which may collect moisture or oil shall be drained in the field even when drainage is not called

for on the plans, provided that none of the parts drained are unduly weakened by the drainage openings.

(d) Lubrication: All rotating and sliding parts shall be thoroughly cleaned and well lubricated during erection. All parts shall be lubricated before the operating machinery is tested. Counterweight and operating ropes shall be given one coat of approved lubricant.

(e) Camber, General Requirements: When movable bridges are in process of erection, 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 the main truss connections shall have been driven or the joints 100 per cent pinned and bolted, so that no slip will occur in 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 deck, the elevation at all panel points shall conform to the specified grade line.

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 alignment to insure correct closing and locking.

(h) Alignment of Trunnion Bearings: Special care shall be taken in aligning 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 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 it through a number of complete cycles to 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 operating parts to become heated may be discovered. All defects found in the operation of the span shall be corrected.

8.15 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 preferably be of concrete supported in a steel box or by a steel frame. 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 of 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 to the amount of 10 percent shall be provided. 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 this clearance the counterweight ropes shall be assumed to stretch 2 per cent of their calculated length.

Concrete for counterweights and adjusting blocks shall be Class A conforming to the applicable requirements of

Section 5, Part 4, Division II. The concrete shall weigh about 148 pounds per cubic foot, unless otherwise specified. Steel punchings or scrap metal may be used when necessary to increase the weight. If clean steel punchings are used, and placed in layers and grouted with a mortar composed of one part of Portland cement and 2 parts of 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 about 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 necessary, the location of the center of gravity of the moving span, including 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 pockets of the counterweights are to be assumed one-half full when determining the size of counterweights.

The determination of the proper mixture for the counterweights in order to give the proper 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 one, two, three and seven days old. This record of test blocks must be submitted to the engineer for approval before concreting is commenced and these tests shall be made by the contractor in time to have this 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, and where necessary, the detail drawings of the counterweights, and the construction of 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 the engineer may require 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 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.

8:16 Power Plant:

(a) General: This item shall be as provided in Division IV, Design of Movable Bridges, of these specifications and as shown on the plans except as provided herein.

(b) Power Supply: On electrically operated bridges the contractor shall make all necessary arrangements with the power company and shall bring the electrical power service to the switchboard in the operating house. Unless otherwise shown the electrical service shall be 220/110 volts, 4 wire delta, 3 phase, 60 cycles 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 inspection and acceptance by the Department shall be included in the lump sum bid under Item 5-8-2.

(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 stand operating voltages and currents in accordance with N.E.M.A. standards. The contractor shall give the engineer ample notice before making final tests so that the

engineer may arrange to have an observer present while the tests are being made.

(d) Grounding and Bonding: The entire system shall be grounded and bonded in accordance with the National Electric Code. 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 have 600 volt moisture and heat resistant insulation, Type RH-RW, National Electric Code Designation, with neoprene jacket, and shall be installed in metal conduits. All conductors, except spares, shall be terminated on high pressure connector barrier type properly identified terminal blocks, and shall be tagged with fiber discs one inch in diameter with the proper identification stamped thereon. Conductors smaller than #12 AWG shall not be used. Conductors #8 AWG and smaller may be solid or stranded; conductors #6 AWG and larger shall be stranded.

Except as otherwise provided herein, the contractor shall not be required to furnish samples of the various types of wires and cables to the engineer, but shall be required to furnish 8 copies of detailed manufacturer's description of each of the various types and sizes of wires and cables to the Bridge Design Engineer of the Department of Highways in Baton Rouge, Louisiana, for approval. The description shall be full and complete, and shall include the manufacturer's name, the size of conductors, the thickness and type of insulation, the thickness and type of cover, and the overall diameter of wires. In addition to the above, the description for cables shall include the size and number of conductors, the type and thickness of sheath, the type and size of armor, 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 at 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 description, the engineer reserves the right to obtain samples of the wires and cables delivered at the bridge and to have the samples tested.

(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 and brakes.

All conduits, condulets, fittings, clamps, clamp backs, and all other hardware shall be hot dipped galvanized. Insulating end bushings shall be used at the ends of all conduit runs to prevent injury to the conductors. One-eighth inch diameter drain holes shall be provided at the low point of all conduit runs. Threads shall be painted with white or red lead before assembly. Conduit clamps and straps shall be malleable iron.

(g) Junction Boxes: Junction boxes shall be made of cast aluminum, cast iron, or welded steel plates, with a minimum thickness of ¼". All corners and edges shall be well rounded, and all welds ground smooth. Junction boxes shall have copper screened drain holes not less than ½" diameter. Cast iron and welded steel junction boxes shall be galvanized before assembly, but after all grinding and welding has been completed.

Junction boxes shall have sufficient terminal blocks to terminate all conductors except spares. Mounting terminal blocks on the sides of junction 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 4 inches between terminal blocks and the sides of the junction box. These distances shall be increased if there is a large number of blocks in each row to provide room for the conductors. The minimum depth of the junction box shall be twice the outside diameter of the largest conduit entering the junction box plus 2 inches, but in no case less than 6 inches.

Junction boxes shall have hinged covers, equipped with soft rubber gaskets to form watertight seals, and held closed with galvanized steel hinged bolts with winged nuts.

(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. Marking strips shall be provided and each connector shall be identified.

(i) Internal Combustion Engines: Internal combustion engines shall be as shown on the plans.

(j) Fuel Tank: Fuel tanks shall be of 100 gallon capacity and constructed of galvanized sheet metal not less than ⅛" thick. The tank shall be located outside the engine room, below the level of the intake, preferably suspended under the floor of the engine room. The tank shall be equipped with drain, and vent and filler pipes located

outside the engine room. The filler pipe shall be so constructed as to permit gauging of the tank with a calibrated stick gauge.

(k) Equipment and Apparatus Substitutions: All equipment and apparatus shall be the approved equal of that shown on the plans. The contractor shall submit such plans and descriptions to the Bridge Design Engineer of the Department of Highways in Baton Rouge, Louisiana, of all equipment and apparatus he proposes to substitute for that shown on the plans to establish that such equipment and apparatus is the equivalent of that specified.

8.17 Operating House:

The operating house shall be constructed in accordance with the plans. All obviously necessary parts or fittings, not specifically shown or called for shall be furnished by the contractor, as if shown or called for, without extra charge.

8.18 Machinery Houses:

Machinery houses shall be constructed in accordance with the plans. All obviously necessary parts or fittings, not specifically shown or called for, shall be furnished by the contractor, as if shown or called for, without extra charge.

MEASUREMENT AND PAYMENT

8.19 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, oil burning navigation lights, 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) Power Plant: Power plant will be measured by the lump and the measurement shall include all electrical motors, internal combustion engines with all incidental parts, electrical generator sets, electrically operated brakes, switchboard and control desk with their attachments and electrical parts, controllers, resistances, limit switches, transformers, circuit breakers, electric navigation lights, navigation 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.

(c) Operating House: The operating house will be measured by the lump and the measurement 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 under "Bearing Piles," Section 1, Part 5, Division II.

(d) Machinery Houses: Machinery houses will be measured by the lump and the measurement shall include all obviously necessary parts of the houses.

(e) Class A concrete in counterweights will be measured by the cubic yard and the yardage to be paid for shall be determined as provided in Article 5.28, Part 4, Division II. No deduction in the volume of concrete will be made for steel punchings or scrap metal which may be used when necessary to increase the weight.

Deformed reinforcing steel or structural steel used in counterweights, as the case may be, will be measured as provided in Articles 6.09 and 7.22, Part 4, Division II.

8.20 Basis of Payment:

Machinery, power plant, operating house, machinery houses, and concrete, measured as provided above, shall be paid for at the contract prices per unit for "Movable Bridge Machinery," "Power Plant," "Operating House," "Machinery Houses," and "Class A Concrete in Counterweights," as the case may be, which price and payment shall constitute full compensation for furnishing and placing all material; for equipment, tools, labor, and incidentals and the performance of all work necessary to complete the item.

Deformed reinforcing steel or structural steel used in counterweights, as the case may be, will be paid for as provided in Articles 6.10 and 7.23, Part 4, Division II.

Payment will be made under:

Item 5-8-1, Movable Bridge Machinery, per lump.
Item 5-8-2, Power Plant, per lump.
Item 5-8-3, Operating House, per lump.
Item 5-8-4, Machinery Houses, per lump.
Item 5-8-5, Class A Concrete in Counterweights, per cubic yard.

SECTION 9

OPEN GRID BRIDGE FLOORING

9.01 Description:

This item shall consist of furnishing and installing steel grid flooring of the type indicated on the plans.

9.02 Design:

The steel grid flooring shall meet the requirements for design as contained in the current A.A.S.H.O. Standard Specifications for Highway Bridges.

MATERIALS

9.03 Steel:

All steel, except rivet steel, shall conform to the requirements of Article 7.03 (a), Part 4, Division II, except that copper bearing steel, meeting the requirements of Article 7.05, Part 4, Division II, will be permitted.

Rivet steel shall meet the requirements of Article 7.04 (a), Part 4, Division II.

Unless otherwise specified, the contractor shall make the chemical analyses and physical tests as stipulated in the applicable Standard Specifications of the A.S.T.M., and shall furnish the Testing and Research Engineer of the Department of Highways, in Baton Rouge, with 7 copies of the certified reports of the chemical analyses and physical tests.

9.04 Concrete:

Concrete, when required for filler, shall be Class A meeting the applicable requirements of Section 5, Part 4, Division II.

CONSTRUCTION METHODS

9.05 Fabrication:

The steel grid floor shall conform to all requirements of these specifications, even though the manufacturer's specifications are different. Deviations from these specifications to conform to manufacturer's specifications, where different, will not be permitted without approval of the engineer.

9.06 Working Drawings:

Working drawings shall be submitted by the contractor in conformity with the requirements for "Shop Drawings," Article 7.14 (a), Part 4, Division II.

9.07 Notice of Beginning of Work:

The contractor shall give the engineer ample 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 the engineer has been so notified.

9.08 Facilities for Inspection:

The contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the works.

9.09 Inspector's Authority:

Inspector shall have the authority to reject any material or work which does not meet the requirements of these specifications. In case of dispute the contractor may appeal to the engineer, whose decision shall be final.

9.10 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.

9.11 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 injure the metal.

9.12 Arrangement of Sections:

Where the main elements are normal to the center line of roadway, the units generally shall be of such length as to extend over the full width of the roadway for roadways up to 30 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 center line 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.

9.13 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 normal 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 center line 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 completed floor after dead-load deflection shall conform to the longitudinal camber shown on the plans.

9.14 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 along their edges by welding of bars or by riveting them. The rivets may be cold driven.

9.15 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 welds shall be subject to the approval of the engineer, but in no case shall they be less than the manufacturer's standards.

The ends of all the main members of the floor 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.

9.16 Welding:

All shop and field welding shall be done in accordance with current standard specifications for Welded Highway and Railway Bridges of the American Welding Society, and as required in Article 2.06, Part 4, Division II.

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. Any clinkers or slag caused by flame cutting or other causes shall be removed before welding.

9.17 Painting:

The open steel grid floor shall receive one shop coat and 3 field coats of paint in accordance with the requirements of

Section 4, Part 5, Division II. Painting of concrete filled grid floor shall be in accordance with last paragraph of this article.

The shop coat of paint may be applied by dipping, spraying or brushing. Paint, for the shop coat, of composition different from that stipulated in these specifications will be considered and the engineer will advise before bids are received, if requested, whether any particular manufacturer's paint is satisfactory for the shop coat. Particular attention is directed to the cleaning of surfaces to be painted. Slag shall be cleaned from all welds, and spatter, rust, loose mill scale, dirt, oil or grease, and all other foreign substances shall be removed from all surfaces to be painted before the shop coat of paint is applied.

Field coats may be applied by brushing or spraying. If paint is sprayed, it may be applied with either a single nozzle gun or a gang sprayer appropriately rigged up. Spraying of paint shall be done when the wind is comparatively calm and care shall be taken that movable parts of machinery and concrete surfaces are properly protected during the application of the paint. The flooring shall be sprayed before applying the final field coat to surfaces below the open grid floor.

For the filled type of grid flooring, the underside of the bottom plate and the outer faces of headers, trim bars and end bars shall receive one coat of shop paint, and 3 coats of field paint.

9.18 Use of Alternate Sections:

If the contractor prefers to use a type of steel grid flooring other than that shown on the special plans for a particular bridge, he will be permitted to substitute another section selected from the various types shown on the standard plan titled "Open Grid Bridge Flooring," included in the project plans. However, in each case, the plans will specify which of the alternate sections will be considered equal to the section shown on the special plan, and therefore acceptable to the engineer. If the use of an alternate section requires supporting members in addition to those shown on the special plans, the maximum spacing of such members shall be as shown on the standard plan for the section being used. The size of such members shall be determined on the basis of the specified design load, as shown on the plans, and in

accordance with the current A.A.S.H.O. Standard Specifications for Highway Bridges for design methods. In the event an alternate section is used, all structural changes in the design of the floor system necessitated by the substitution shall be incorporated in the shop details covering the grid flooring so that it will be possible to check the entire floor system from the information shown in the shop details.

9.19 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 one 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 meet the requirements of Article 9.04. The concrete shall be thoroughly compacted by vibrating the steel grid floor. The vibrating device and the manner of operating it shall be subject to the approval of the engineer.

MEASUREMENT AND PAYMENT

9.20 Method of Measurement:

The steel grid flooring shall include all steel which enters into the fabrication, assembling and erecting of the flooring, and all welding and/or riveting required. Structural shapes such as curb plates and angles, risers, etc., if called for on the plans, will not be measured as steel grid flooring, but as fabricated carbon steel as provided in Article 7.22, Part 4, Division II. However, base plates for curbs will not be measured separately, but will be included in the area for measurement of the steel grid flooring. If an alternate section is used, no supporting members in addition to those shown on the special plans will be measured, as they will be considered an integral part of the alternate flooring.

Measurement will be made by the square foot for the area of steel grid flooring remaining in the completed and accepted structure. Measurements will be made to the outside line of the grid flooring, including the headers, trim,

or end bars surrounding the grid, after the flooring is in place. Openings for manholes, notches for leaf guide castings, etc., will not be deducted.

Concrete used for filling steel grid flooring will be measured by the cubic yard. Deduction in the quantity of concrete will be made for the volume of steel grid flooring enclosed by the concrete. In order to compute the net volume of concrete, the weight per square foot of the open floor (weight taken from standard plan) shall be converted into volume per square foot of flooring, at the rate of 490 pounds per cubic foot.

9.21 Basis of Payment:

The number of square feet of completed and accepted steel grid flooring, measured as provided above, shall be paid for at the contract price per square foot for "Open Grid Bridge Flooring" of the type shown on the plans, or of the approved alternate. This price and payment shall constitute full compensation for furnishing, fabricating, erecting, and painting, and for all labor, tools, equipment and incidentals necessary to complete the item including all trim, header and end bars, and base plates for curbs. It shall also include the cost of supporting members additional to those shown on the special plans, when such members are required in order to complete an alternate section.

Concrete will be paid for under Item 4-5-1 as provided in Article 5.29, Part 4, Division II.

Structural steel, when called for on the plans, will be paid for under Item 4-7-1 as provided in Article 7.23, Part 4, Division II.

Payment will be made under:

Item 5-9-1, Open Grid Bridge Flooring, per square foot.

SECTION 10

CONCRETE APPROACH SLABS

10.01 Description:

This item shall consist of the construction of concrete approach slabs for bridges and overpasses, in accordance with the details, and at the locations and of the dimensions shown on the plans.

MATERIALS

10.02 Concrete:

Concrete for approach slabs and bolster blocks shall be either Class A meeting the applicable requirements of Section 5, Part 4, Division II, or concrete meeting the requirements for "Portland Cement Concrete Pavement" of Section 5, Part 3, Division II.

Concrete used in boxes under the approach slab shall be Class A meeting the requirements specified herein.

10.03 Reinforcing Steel:

Reinforcing steel for use in approach slabs shall be deformed bars meeting the applicable requirements of Section 6, Part 4, Division II.

10.04 Structural Steel:

Structural steel, when required by the plans, shall be "Fabricated Carbon Steel" meeting the applicable requirements of Section 7, Part 4, Division II.

10.05 Mud Pump Connections:

Mud pump connections, when required, shall conform to the details shown on the plans.

10.06 Expansion Joint Material:

(a) Asphalt Mineral Filler: When required by the plans, this type of joint filler shall meet the requirements of Article 5.16, Part 3, Division II.

(b) Premoulded Joint Filler: When required by the plans, premoulded joint filler shall meet the requirements of either type, as the contractor elects, contained in Article 5.15, Part 3, Division II.

(c) Filler Composed of Cotton Seed Hulls and Emulsified Asphalt: When required by the plans, this type of filler shall meet the following requirements:

The mixture shall be composed of approximately 0.9 gallon of Emulsified Asphalt Grade EA-4, meeting the requirements of Article 3.06, Part 2, Division II, per cubic foot of cotton seed hulls measured loose. The mixture shall be permitted to age a minimum of 48 hours before use.

CONSTRUCTION METHODS

10.07 General:

(a) Concrete: All concrete work performed in constructing the approach slabs and the bolster blocks and boxes under the approach slabs shall be done in accordance with the specifications for "Concrete," Section 5, Part 4, Division II.

(b) Reinforcing Steel: Reinforcing steel required by the plans shall be placed in accordance with the applicable requirements of Section 6, Part 4, Division II.

10.08 Roadway Finish:

The roadway finish shall be performed as specified under Article 5.26(g), Part 4, Division II.

10.09 Fabricated Carbon Steel:

Fabricated carbon steel, when required by the plans, shall be placed in accordance with the applicable requirements of Section 7, Part 4, Division II.

10.10 Expansion Joints:

Expansion joints constructed of asphalt mineral filler shall conform to the details shown on the plans.

Expansion joints of premoulded joint filler shall be constructed in accordance with Article 5.23, Part 4, Division II.

Expansion joints requiring the use of cotton seed hulls and emulsified asphalt shall be constructed in accordance with the details shown on the plans.

10.11 Black Traffic Stripes:

When indicated on the plans or required by the special provisions, traffic stripes shall be applied on the approach slabs at the exact location shown on the plans or designated by the engineer, all in accordance with the requirements of Article 5.44, Part 3, Division II.

10.12 Mud Pump Connections:

When mud pump connections are specified, they shall be placed as provided on the plans. In the event a metal cap is not fabricated, the contractor shall fill each connec-

tion with firmly packed earth to within 2 inches from the top, then fill the remainder of the hole with asphalt mineral filler.

10.13 Bolster Blocks:

Bolster blocks, when required, shall be constructed in accordance with the requirements of these specifications and as indicated on the plans. The contractor shall place 3 layers of tar paper, approved by the engineer, or one coat of paint or heavy grease between the bolster block and the pavement slab and expansion joint adjacent to the approach slab, all as shown on the plans.

MEASUREMENT AND PAYMENT

10.14 Method of Measurement:

Concrete approach slabs will be measured by the square yard, complete in place and accepted. The width for measurement will be the width from outside to outside of completed approach slab, as constructed in accordance with the plans or as directed by the engineer. The length will be the actual center line length measured along the riding surface.

Bolster blocks constructed under the approach slabs and accepted, regardless of the type of concrete used, shall be classified as "Class A Concrete" and measurement will be made as provided under Article 5.28, Part 4, Division II.

Concrete boxes constructed under approach slabs shall be classified as "Class A Concrete" and measurement will be made as provided under Article 5.28, Part 4, Division II.

Reinforcing steel shall be measured as "Deformed Reinforcing Steel" as provided under Article 6.09, Part 4, Division II.

Structural steel shall be measured as "Fabricated Carbon Steel" as provided under Article 7.22, Part 4, Division II.

10.15 Basis of Payment:

The number of square yards of completed and accepted approach slabs, measured as provided above, shall be paid for at the contract unit price per square yard for "Concrete Approach Slabs," which price and payment shall constitute full compensation for furnishing all materials except

concrete for concrete bolster blocks and concrete boxes, reinforcing steel and structural steel; for all labor, tools, equipment and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-10-1, Concrete Approach Slabs, per square yard.

Payment for concrete used in bolster blocks and boxes under the slab will be made under Item 4-5-1 as provided under Article 5.29, Part 4, Division II.

Payment for reinforcing steel will be made under Item 4-6-1 as provided under Article 6.10, Part 4, Division II.

Payment for structural steel will be made under Item 4-7-1 as provided under Article 7.23, Part 4, Division II.

SECTION 11

FENCE

11.01 Description:

This item shall consist of furnishing and constructing or rebuilding fence in accordance with the plans and these specifications.

MATERIALS

11.02 Barbed Wire:

Barbed wire shall be 4 point hog wire consisting of tough annealed strands heavily galvanized of the gage shown on the plans.

11.03 Mesh Wire:

Mesh wire shall be constructed on the hinged joint principle. The stays or uprights shall be separated pieces of wire which connect with the horizontal or strand bars and shall be wrapped securely around the strand, forming a complete joint or lock. All wire shall be basic Open Hearth Steel, heavily galvanized.

11.04 Staples:

Staples shall be made of galvanized steel wire and shall be of the size shown on the plans.

11.05 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 posts furnished. Wire shall be not less than 0.120 inch in diameter.

11.06 Posts:

Line posts may be either treated timber posts or steel posts, except as may be provided elsewhere herein, however the same type of posts furnished for line posts shall be used throughout any particular 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: All treated posts shall be Southern Pine of the dimensions shown on the plans. Any of the treatments provided herein will be permitted.

1. Seasoning: Posts to be treated with creosote or pentachlorophenol-petroleum solution shall be air or artificially seasoned prior to treatment. Posts to be treated with Osmosalts shall be of green or unseasoned wood only, prior to treatment.

2. Preservative Treatment with Creosote or with Pentachlorophenol-Petroleum Solution: Treatment of posts with either creosote or pentachlorophenol-petroleum solution shall conform to the applicable requirements of Section 3, Part 5, Division II.

3. Preservative Treatment with Osmosalts: Posts to be treated by this process shall be green or unseasoned wood manufactured from live, standing trees and in no case shall timber be accepted for treatment that has end checking greater than one inch or that has any surface checking whatsoever.

The chemical composition of the salts treatment shall meet the following requirements:

	Per Cent by Weight	
	Min.	Max.
Sodium Fluoride	30	38
Dinitrophenol	5	10
Potassium Bichromate	30	38
Sodium Arsenate	22	28

The method of treatment shall be as follows: Posts to be treated shall be delivered to the treating site with the bark intact, and shall be treated within a period not greater than 20 days after the trees are felled. The trees from which the posts are to be produced shall be branch-trimmed and cut in the woods to desired length as soon as possible after the tree has been felled. Posts shall not be peeled more than 24 hours before application of treatment.

The preservative shall be mixed with water to such a consistency that, when applied to the entire surface area of the freshly peeled post, a sufficient quantity of the Osmosalts (dry) to insure a minimum of 0.3 pound per cubic foot of material shall remain uniformly distributed over the surfaces. The treatment shall be applied either by dipping, spraying or brushing.

After application, the posts shall be dead-stacked in solid piles (no stripping). The stacks shall be stacked on timbers, or other approved material, separating the posts from the ground. At the end of each day's treatment, the stack or stacks shall be completely covered on all sides and ends with an approved waterproof paper, or other suitable material, which shall be securely fastened down. Earth or other satisfactory material shall be piled around the base of the stack, so as to eliminate as much as possible any free circulation of air from under the stacks. The purpose of all such covering shall be to prevent subsequent rainfall from washing off the preservative mixture, to retard seasoning, and in order to permit the preservative to diffuse into the wood by natural osmotic pressure and capillary attraction.

The posts shall remain under the protective covering until such time as the Osmosalts have penetrated into the timber to a minimum depth of ⅜ inch as determined by the standard Zirconium-Alizarine color reagent, or as determined by the Department's inspector; however, the minimum time under cover shall be not less than 10 days for the first inch, plus 5 days for each additional inch of diameter.

After the proper penetration has been secured, the stacks shall be uncovered and the posts shall be air-seasoned for at least 30 days before using.

(b) Steel Posts: Steel posts furnished for line posts may be one of the suggested types shown on the plans or such other type the contractor elects to use, provided

that the type furnished shall meet the requirements of these specifications.

Steel posts furnished for end posts, corner posts and bracing posts shall be of the type and approximate dimensions shown on the plans, or such other equivalent type the contractor elects to use, provided that the type furnished shall meet the requirements of these specifications.

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 post. Posts with punched tabs used for fastening wires are not acceptable because of the risk of injury to fence wires when such tabs are crimped around the wires, and of the tendency of tabs to fracture upon removal and refastening of fence. In addition, 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 shall have a nominal weight of 1.33 pounds per foot, exclusive of anchor plate. Corner, end and bracing posts shall have a nominal weight of 4.10 pounds per linear foot. Permissible variation in total weight of posts in any one shipment shall be a maximum of 3½ per cent over or under the nominal weights.

Steel posts shall be furnished in the lengths shown on the plans. Permissible variations shall be a maximum of one inch under and 2 inches over the designated lengths.

Posts shall be fabricated of hot-rolled steel sections meeting either of the requirements given in the following table:

Grade	Tensile Properties	
	Yield Strength	Ultimate Strength
	lb./sq. in. (min.)	lb./sq. in. (min.)
Hot-rolled carbon steel—minimum carbon content 0.35 per cent	40,000	70,000
Hot-rolled rail steel	50,000	80,000

Note: Rail steel products shall be rolled from standard tee-section steel rails. No other materials, such as those known by the terms "rerolled," "rail steel equivalent" and "rail steel quality," shall be substituted.

Line posts shall be furnished with anchor plates of the approximate shape and dimensions shown on the plans and so tapered as to facilitate driving. The anchor plates shall weigh a minimum of 0.67 pound each. The plates shall be clamped, welded, or riveted to the posts in a substantial manner to prevent displacement of the plates when the posts are driven.

Steel posts, including anchor plates on line posts, may be either painted or galvanized, however, all steel posts furnished for the project shall have the same finish. Painted posts shall be cleaned of loose scale prior to finishing, and one or more coats of high-grade, weather-resistant, special steel paint or enamel shall be applied and baked. The color shall be satisfactory to the engineer. Galvanized posts shall be galvanized by the hot-dip process, and shall have a uniform coating of Prime Western spelter or better grade.

Excessive bow, camber, twist, or other injurious defects in posts shall be considered cause for rejection of such posts.

11.07 Braces:

(a) Timber Braces: All timber braces shall be of the dimensions shown on the plans and shall be treated timber meeting the applicable requirements of Section 8, Part 4, Division II. The braces shall be treated in the same manner as provided for treated timber posts in Article 11.06 (a).

(b) Steel Braces: Steel braces shall be of the approximate type and dimensions shown on the plans. Bracing members shall have a nominal weight of 3.19 pounds per linear foot. Braces shall be furnished with holes placed in proper position and of proper size for fastening braces to the posts. Fabrication and grade of steel, finish, permissible tolerances, and cause for rejection shall be the same as provided for steel posts in Article 11.06 (b).

11.08 Concrete:

Concrete for posts and bracing blocks as shown on the plans shall be Class R conforming to the applicable requirements of Section 5, Part 4, Division II.

CONSTRUCTION METHODS

11.09 New Fence:

The fence shall be constructed at the locations indicated on the plans or as directed by the engineer. Posts shall be set vertically to the full depth shown on the plans and accurately spaced and aligned.

(a) Timber Posts: When timber posts are used, the post holes shall be backfilled, with carefully selected material for the backfill, and thoroughly compacted by tamping. Timber braces shall be placed at angles, corners, gates, and at the beginning and end of fence and on straight sections shall not be more than 500 feet apart. The wire shall be stretched and nailed to the posts with at least one staple for each horizontal strand and as many additional staples as required to make a secure and workmanlike fence.

(b) Steel Posts: When steel posts are used for line posts, the posts shall be driven by approved methods in such manner as to avoid burring or otherwise damaging the posts. Steel posts used for end, corner or bracing posts shall be set in concrete as shown on the plans. Steel braces shall be placed at angles, corners, gates, and the beginning and end of fence and on straight sections shall not be more than 500 feet apart. Braces shall be fastened to the steel posts in an approved manner, and the ground end of each brace shall be set in a concrete block. Fence wire shall not be placed until the concrete has set sufficiently. The wire shall be stretched and fastened to the metal posts in the manner specified for the type post used. A minimum of 4 horizontal wires shall be fastened to the post for the mesh wire; and each strand of barbed wire shall be fastened to the post. The fence shall be completed in a secure and workmanlike manner.

If painted steel posts and braces are used, any exposed surfaces that have been chipped or otherwise damaged, either in shipment or in erecting the posts and braces, shall be given one coat of the same type paint placed by the fabricator.

11.10 Rebuilt Fence:

Where indicated on the plans or directed by the engineer, 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.

11.11 Fence Posts in Rebuilt Fence:

New posts shall be used in rebuilding fence where indicated on the plans or directed by the engineer. New posts shall be of the same general type as those in the existing fence, that is, timber posts shall be used to replace existing timber posts, steel posts to replace steel posts, etc., however all new posts shall meet the applicable requirements of Article 11.06. The posts shall be installed in the rebuilt fence in the same manner as specified for new fence.

Posts furnished for ornamental fence or other special types of fence shall be similar in all respects to posts in the existing fence.

11.12 General:

The contractor shall take every possible precaution and care against damage in removing existing fence, either to be rebuilt or replaced with new fence, and he shall be responsible for any damage to crops or property occasioned by allowing cattle, horses, mules, and other animals to roam through gaps left by workmen.

MEASUREMENT AND PAYMENT

11.13 Method of Measurement:

Measurement of Fence: Fence will be measured by the station (100 linear feet) and the quantity determined by measurement of the length of fence actually completed.

Measurement of New Posts: New posts will be measured by the post and the number of new posts installed in rebuilt fence shall be counted.

11.14 Basis of Payment:

The number of stations of fence and number of posts completed and accepted, measured as provided above, shall be paid for at the contract unit price per unit for "Fence" and "Fence Posts," complete in place, which price and payment shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

The unit price bid for "New Fence" shall include the furnishing and installing of posts. The unit price bid for "Rebuilt Fence" shall not include furnishing and installing new posts, the cost of same will be paid for at the contract unit price bid for "New Fence Posts."

Payment will be made under:

Item 5-11-1, New Barbed Wire Fence, per station.
Item 5-11-2, New Combination Mesh and Barbed Wire Fence, per station.
Item 5-11-3, Rebuilt Fence, per station.
Item 5-11-4, New Fence Posts, per post.

SECTION 12

GATES

12.01 Description:

This item shall consist of furnishing and erecting prefabricated aluminum or galvanized steel gates, as selected by the contractor, of the dimensions shown on the plans and constructed in accordance with these specifications.

MATERIALS

12.02 Gates:

Design of metal gates shown on the plans is of a type acceptable to the Department. Gates of any other design may be furnished if prior approval is obtained from the Department.

The contractor, prior to erecting gates, shall submit to the Department for approval, specifications covering design and fabrication of the type gates he contemplates furnishing.

All gates shall be of rigid construction, and after erection shall not show any sag or warp.

12.03 Posts:

Posts may be either treated timber or metal posts, of the dimensions shown on the plans.

(a) Treated Timber Posts: Treated timber posts shall conform to the requirements of Article 11.06(a), Part 5, Division II.

(b) Metal Posts: Metal posts shall be made of galvanized steel pipe, standard weight, conforming to the applicable requirements of the Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, A.S.T.M. Designation: A 120.

12.04 Hardware:

Hinges, washers, nails, staples, well chain, and latch shall be of standard quality satisfactory for use with the type of gate and posts selected for use and acceptable to the engineer.

12.05 Gate Stops:

(a) Treated Timber Posts: The gate stop of the dimensions shown on the plans shall be treated timber conforming to the applicable requirements of Section 8, Part 4, Division II. Gate stops shall be treated in the same manner as specified for treated timber posts in Article 11.06 (a), Part 5, Division II.

(b) Metal Posts: The gate stop shall be galvanized steel, suitable for welding to the post and acceptable to the engineer.

12.06 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 the applicable requirements of Section 8, Part 4, Division II. Stop posts shall be treated in the same manner as specified for treated timber posts in Article 11.06 (a), Part 5, Division II.

12.07 Concrete:

Concrete for metal post blocks as shown on the plans shall be Class R conforming to the applicable requirements of Section 5, Part 4, Division II.

CONSTRUCTION METHODS

12.08 General:

The gates shall be constructed at the places indicated on the plans or as directed by the engineer.

Posts shall be set vertically to the full depth shown on the plans and accurately spaced and aligned. Fence wire shall be attached to gate posts in a manner satisfactory to the engineer.

If timber posts are used, the post holes shall be backfilled, with carefully selected material for the backfill, and thoroughly compacted by tamping. The timber gate stop shall be attached in accordance with the plan details.

If metal posts are used, the posts shall be set in concrete as shown on the plans. Gates shall not be hung or the posts otherwise disturbed until the concrete has set sufficiently. The metal gate stop shall be welded to the post as directed.

The bottom edge of the gate shall be elevated above ground line as shown on the plans. The finished gate shall swing free and shall be erected in a workmanlike manner acceptable to the engineer.

MEASUREMENT AND PAYMENT

12.09 Method of Measurement:

Gates will be measured, complete in place, and each completed gate will be counted.

12.10 Basis of Payment:

The number of gates completed and accepted, measured as provided above, shall be paid for at the contract unit price each for "Gates," complete in place, which price and payment shall constitute full compensation for furnishing all materials including posts, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-12-1, Single Swinging Walk Gates, per gate.

Item 5-12-2, Single Swinging Driveway Gates, per gate.

Item 5-12-3, Double Swinging Driveway Gates, per double gate.

SECTION 13

ASPHALT PLANK

13.01 Description:

This item shall consist of furnishing asphalt plank (plain) of the thickness shown on the plans, and installing such plank on the creosoted timber sub-floor at the bridge locations indicated on the plans.

MATERIALS

13.02 Asphalt Plank:

Asphalt plank shall be plain, conforming to the Specifications for Asphalt Plank, A.S.T.M. Designation: D 517.

13.03 Cutback Asphalt:

Cutback asphalt shall be of the RC-2 grade and shall conform to the specifications for same contained in Article 2.07, Part 3, Division II.

13.04 Rolled Roofing:

Rolled roofing shall conform to the Specifications for Asphalt Roofing Surfaced with Powdered Talc or Mica, A.S.T.M. Designation: D 224, 55 pound grade.

CONSTRUCTION METHODS

13.05 General:

The creosoted timber sub-floor shall be laid in such a manner that the maximum difference in elevation between adjacent planks shall not exceed ⅛ inch. It shall be cleared of all excess materials, tools, equipment and other materials not essential to the laying of the wearing surface and shall be swept with hand brooms clean and free of all dust, dirt and other debris before proceeding with the placing of the rolled roofing.

13.06 Rolled Roofing:

The asphalt roofing shall be laid with edges lapped 3 inches and tacked to the sub-floor with 1¼ inch, ⅝ inch diameter head, galvanized roofing nails at 12-inch centers. The roofing shall be bent down over the outside edges of

the timber sub-floor. Any breaks or holes found in the roofing after it is laid shall be patched neatly with fitted pieces of roofing tacked into place and sealed with cutback asphalt.

13.07 Asphalt Plank:

Preparatory to laying asphalt plank, the roofing surface shall be swept clean and free of all dust, dirt and other debris, and then given a uniform, even coating of grade RC-2 cutback asphalt, applied not less than 1/32 inch thick nor more than 1/16 inch thick with an air gun or sprinkling pot, as specified.

The asphalt plank which, preferably, shall be of 8 inch widths by the lengths indicated on the plans or specified by the engineer, shall be laid not less than 15 minutes nor more than 2 hours after application of the asphalt. Each plank shall be nailed in the manner specified on the plans. The nails shall be countersunk, but in no case shall they be countersunk less than 1/8 inch nor more than 1/4 inch below the wearing surface. Suitable methods shall be employed to insure a close end and side fit between adjacent planks. Asphalt planks shall be laid as shown on the plans with broken joints and rolled or weighted to secure solid bearing in the cutback asphalt.

Small spaces, cracks and nail holes shall be filled with hot asphalt and all surplus material removed after cooling.

After laying of planks is completed, the entire surface shall be given a uniform coating of RC-2 cutback asphalt at the rate of 0.15 gallon per square yard and immediately thereafter dry sand at the rate of 15 pounds per square yard shall be sprinkled over the asphalt in a uniform coating. The entire floor shall then be rolled as directed with a roller weighing not less than 2 1/2 tons.

MEASUREMENT AND PAYMENT

13.08 Method of Measurement:

Asphalt plank, complete in place and accepted, will be measured by the square foot. The width for measurement will be the width from outside to outside of completed asphalt planking, as constructed in accordance with the plans. The length will be the actual center line length measured along the riding surface.

13.09 Basis of Payment:

The number of square feet of asphalt plank complete in place and accepted, measured as provided above, shall be paid for at the contract unit price per square foot for "Asphalt Plank," which price and payment shall constitute full compensation for furnishing all materials including rolled roofing, for all labor, tools, equipment and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-13-1, Asphalt Plank (¾" Thick), per square foot.
Item 5-13-2, Asphalt Plank (1" Thick), per square foot.
Item 5-13-3, Asphalt Plank (1¼" Thick), per square foot.
Item 5-13-4, Asphalt Plank (1½" Thick), per square foot.
Item 5-13-5, Asphalt Plant (2" Thick), per square foot.

SECTION 14

HANDRAILS

Concrete Handrail
Steel Handrail
Steel Channel Handrail
Pipe Handrail
Steel and Concrete Handrail
Pipe and Concrete Handrail

14.01 Description:

This item shall consist of the furnishing of all materials for and the construction of any of the types of handrail listed above, including handrail posts, as specified on the plans or in the special provisions, and in conformity with the details shown on the plans and in accordance with these specifications.

MATERIALS

14.02 Concrete:

All concrete used in handrail and handrail posts shall be Class A conforming to the applicable requirements of Section 5, Part 4, Division II.

14.03 Reinforcing Steel:

Reinforcing steel shall consist of deformed bars conforming to the applicable requirements of Article 6.02, Part 4, Division II.

14.04 Structural Steel:

Structural steel for handrail and handrail posts shall consist of carbon steel conforming to the requirements of Article 7.03(a), Part 4, Division II.

14.05 Pipe:

(a) General: Pipe shall be standard weight, black or galvanized steel, wrought iron, or aluminum, as indicated on the plans or in the special provisions. When more than one type is indicated by the plans, the type selected for use shall be at the option of the contractor, unless otherwise specifically provided.

(b) Black and Galvanized Steel Pipe: Black and galvanized steel pipe shall be standard weight, conforming to the requirements of the Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, A.S.T.M. Designation: A 120.

(c) Wrought Iron Pipe: Wrought iron pipe shall be standard weight, conforming to the requirements of the Specifications for Welded Wrought-Iron Pipe, A.S.T.M. Designation: A 72.

(d) Fittings: Fittings for steel or wrought iron pipe railings shall be of malleable iron and shall comply with the Specifications for Malleable Iron Castings, A.S.T.M. Designation: A 47. Unless otherwise specified, fittings shall be of the ball pattern, made especially for railings. Fittings used with galvanized pipe shall be galvanized. The galvanizing shall comply with the specifications for the galvanized pipe.

(e) Aluminum Pipe, Fittings and Hardware: Aluminum pipe shall be standard pipe (ASA Schedule 40) conforming to the Specifications for Aluminum-Alloy Pipe, A.S.T.M. Designation: B 241, Alloy GS10A, T6.

Fittings for aluminum pipe railings shall conform to either the Specifications for Aluminum-Base Alloy Sand Castings, A.S.T.M. Designation: B 26, Alloy SG70A, T6, or, the Specifications for Aluminum-Base Alloy Permanent Mold Castings, A.S.T.M. Designation: B 108, Alloy SG70A, T6.

Aluminum alloy bolts, nuts and set screws shall be made from rods conforming to the Specifications for Aluminum and Aluminum-Alloy Bars, Rods and Wire, A.S.T.M. Designation: B 211, Alloy CG42A, T4.

14.06 Hardware:

Any bolts required in handrail construction shall conform to the plans and/or the applicable requirements of Section 7.14 (r), Part 4, Division II.

14.07 Paint:

Paint shall conform to the requirements of Section 4, Part 5, Division II.

CONSTRUCTION METHODS

14.08 Erection:

(a) General: Railings shall be constructed of the type specified, in conformity with the details shown on the plans and the requirements of these specifications. It shall be constructed to the alignment, grade and camber as designated on the plans.

(b) Concrete Handrail: Concrete handrail shall conform to the requirements contained in Article 1.16, Part 4, Division II.

Concrete work and placing reinforcing steel shall be performed in accordance with applicable requirements of Sections 5 and 6, Part 4, Division II.

Expansion joints in concrete rails shall be so constructed as to permit freedom of movement. After all other work is completed, all loose or thin shells of mortar likely to spall under movement shall be carefully removed from all expansion joints by means of a sharp chisel.

(c) Metal Handrail: Fabrication and erection of steel, steel channel and pipe handrails shall conform to the applicable requirements of Section 7, Part 4, Division II.

Metal railings shall be carefully adjusted prior to fixing in place to insure proper matching at abutting joints and correct alignment and camber throughout their length.

Painting of metal railings, except of aluminum, shall comply with the applicable requirements for painting metal surfaces contained in Section 4, Part 5, Division II.

Painting of aluminum pipe railings and fittings will not be required.

(d) Posts: Posts for handrail shall be of the type required by the plans. Posts having their lower ends embedded in concrete shall be set in holes previously prepared for the purpose and grouted with Portland cement mortar.

MEASUREMENT AND PAYMENT

14.09 Method of Measurement:

Handrail will be measured by the linear foot. The length for measurement shall be the actual length of completed railing measured along the face of the railing and end flares from end to end of each line of railing exclusive of any openings in each line of railing between railing posts and between posts and end flares.

14.10 Basis of Payment:

Handrail, placed and accepted, measured as provided above, will be paid for at the contract unit price per linear foot for "Handrail" of the type shown on the plans, which price and payment shall constitute full compensation for furnishing all materials for and erecting the handrail, including posts; for all painting when required; for all fittings, fillers, bolts, nuts and other parts necessary to attach the handrail to the structure upon which it is to be erected; the furnishing of all labor, equipment, tools and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-14-1, Concrete Handrail, per linear foot.

Item 5-14-2, Steel Handrail, per linear foot.

Item 5-14-3, Steel Channel Handrail, per linear foot.

Item 5-14-4, Pipe Handrail, per linear foot.

Item 5-14-5, Steel and Concrete Handrail, per linear foot.

Item 5-14-6, Pipe and Concrete Handrail, per linear foot.

SECTION 15

RIGHT OF WAY MARKERS

15.01 Description:

This item shall consist of furnishing and erecting right of way markers in conformity with the design, dimensions and elevations shown on the plans.

MATERIALS

15.02 Concrete:

All concrete furnished for this item shall be Class A conforming to the applicable requirements of Section 5, Part 4, Division II.

15.03 Reinforcing Steel:

Reinforcing steel shall consist of deformed bars conforming to the applicable requirements of Article 6.02, Part 4, Division II.

15.04 Bronze Marker Plates:

The bronze shall contain not less than 85 per cent copper and shall be true to pattern in form and dimensions.

CONSTRUCTION METHODS

15.05 Right of Way Markers:

The markers shall consist of either reinforced concrete posts or bronze plates as indicated on the plans. The markers shall be installed on right of way lines at points designated on the plans or directed by the engineer.

(a) Marker Posts: The concrete posts shall be cast, finished and cured in the following manner:

1. Casting: The concrete posts shall be cast in mortartight forms. Special care shall be exercised to puddle and tamp the concrete around the reinforcing steel and to avoid the formation of stone pockets. Concrete shall be placed continuously in each post.

2. Finishing: Forms shall be removed as soon as the concrete has hardened sufficiently to permit. All holes and voids shall then be filled with sand-cement mortar of

the same mix as used in the body of the posts and the entire surface of the posts brought to a smooth, neat appearance by rubbing off rough spots with a carborundum block.

3. Curing: As soon as finished the posts shall be covered with 3 thicknesses of wet burlap and kept continuously moist for a period of 7 days, after which they may be set at any time.

(b) Bronze Markers: Bronze markers shall be furnished and installed in concrete at the locations indicated on the plans in a neat and workmanlike manner as directed by the engineer.

15.06 Backfilling:

All posts shall be set to the depth indicated on the plans or as directed by the engineer and post holes shall be backfilled with selected suitable material. The backfill shall be placed in layers, watered and tamped as directed by the engineer.

MEASUREMENT AND PAYMENT

15.07 Method of Measurement:

Right of way markers will be measured by the marker and the number placed and accepted shall be counted.

15.08 Basis of Payment:

The number of markers placed and accepted, measured as provided above, shall be paid for at the contract unit price per "Marker," complete in place, which price and payment shall constitute full compensation for furnishing all equipment, tools, labor, materials, and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-15-1, Right of Way Markers (Concrete Posts), per marker.

Item 5-15-2, Right of Way Markers (Bronze), per marker.

SECTION 16

CATCH BASINS, MANHOLES, INLETS AND PIPE JUNCTIONS

16.01 Description:

This item shall consist of the construction of catch basins, manholes, inlets, pipe junctions or similar structures with the required metal frames and gratings or covers, constructed in accordance with the detail plans and these specifications.

MATERIALS

16.02 Concrete:

Concrete used in the construction of this item shall be Class A meeting the applicable requirements of Section 5, Part 4, Division II.

16.03 Mortar:

All mortar for this item shall be composed of one part cement and 2 parts of sand by volume. The cement and sand shall be thoroughly mixed and sufficient water added to produce a consistency of stiff paste.

16.04 Reinforcing Steel:

Reinforcing steel shall consist of deformed bars and shall conform to the requirements of Article 6.02, Part 4, Division II.

16.05 Brick:

Brick shall conform to the requirements of the Specifications for Sewer Brick (Made from Clay or Shale), A.S.T.M. Designation: C 32. Unless otherwise specified on the plans or in the special provisions, brick shall be grade MA.

16.06 Gray Iron Castings:

Gray iron castings shall conform to the requirements of Article 7.09, Part 4, Division II, and, in addition shall comply with the following:

Surfaces shall be machined where indicated or where otherwise necessary to secure flat true surfaces. All covers, gratings and other castings, fitting into frames, shall fit properly and seat uniformly and solidly.

CONSTRUCTION METHODS

16.07 General:

Where concrete is specified, the structure shall be constructed with concrete placed in accordance with Section 5, Part 4, Division II. Reinforcing steel where required shall be placed in accordance with the plans and securely fastened with wire so as not to be displaced during the placing of the concrete.

Where brick is specified, the structure shall be constructed of brick laid in courses in full and close joints of mortar. Adjoining courses shall break joints ½ brick as nearly as practicable. The courses shall be level in all places except where otherwise necessary. At least one course in every 7 shall be composed of headers. All brick shall be thoroughly wetted immediately before being laid, and broken or chipped bricks will not be allowed in the face of the structure. No spalls or bats shall be used except for shaping around irregular openings or when unavoidable to finish out a course. All joints shall be completely filled with mortar and shall be finished properly as the work progresses.

Inlet and outlet pipes shall be of the same size and kind and meet the same requirements as the pipe with which they are to connect. They shall extend through the walls for a distance beyond the outside surface sufficient for the intended connections and the structure shall be so constructed around them as to prevent leakage along their outer surface.

All castings, metal frames, covers and gratings shall be of the size, type and kind shown on the plans and shall be coated with approved bituminous varnish.

Frames, castings and cast iron bearing plates shall be set in full mortar beds. Castings shall be set accurately to the finished elevation, so that subsequent adjustment will be unnecessary.

Any accumulation of silt, debris or foreign matter of any kind shall be removed from the inside of the structures before final acceptance.

After inspection of the completed structures by the engineer and when directed, the excavated areas which are not occupied by the completed structures shall be refilled to the required elevation with suitable material which shall be placed in layers not more than 6 inches in depth when in a loose condition and each layer thoroughly compacted by

mechanical tamping. If the backfill material is too dry to compact to the satisfaction of the engineer it shall be wetted with water as directed.

MEASUREMENT AND PAYMENT

16.08 Method of Measurement:

Catch basins, manholes, inlets, pipe junctions and similar structures will be measured by the structure complete in place.

16.09 Basis of Payment:

The number of structures, completed and accepted, measured as provided above, shall be paid for at the contract unit price for the item applying thereto, which price and payment shall constitute full compensation for constructing the structure in accordance with the plans or as directed by the engineer; for all excavation and backfilling; for furnishing all castings, metal frames, covers and gratings and all other fittings and materials; and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Inlet and outlet pipes shall be measured with the adjoining pipe and paid for at the corresponding unit price per linear foot.

Payment will be made under:

Item 5-16-1, Catch Basins, Manholes, Inlets and Pipe Junctions, per each.
Item 5-16-2, Catch Basins, per each.
Item 5-16-3, Manholes, per each.
Item 5-16-4, Inlets, per each.
Item 5-16-5, Pipe Junctions, per each.

SECTION 17

ADJUSTING CATCH BASINS, INLETS, MANHOLES AND PIPE JUNCTIONS

17.01 Description:

This item shall consist of removing castings from existing catch basins, inlets, manholes and pipe junctions, adjusting the height of the structure from which the casting was

removed and resetting the casting at the required grade in accordance with the plans and these specifications.

CONSTRUCTION METHODS

17.02 General:

All castings, metal frames, covers and gratings shall be carefully removed, thoroughly cleaned, and all parts thereof placed in good repair and coated with an acceptable bituminous varnish. All cracks and breaks shall be welded and the surfaces of the welds dressed to correspond with the original surface.

All adjustments in catch basins, inlets, manholes and pipe junctions shall be made in a workmanlike manner and materials used shall conform with materials in the existing structure.

If the structure to be adjusted is of reinforced concrete, sufficient removal of the old concrete shall be made to permit bonding of the old and new reinforcing steel. Extensions to concrete structures shall be made with Class A concrete, proportioned, mixed and placed in accordance with Section 5, Part 4, Division II.

Brick structures shall be extended or adjusted with brick laid in courses in full and close joints of mortar composed of one part Portland cement and 2 parts sand, by volume, and thoroughly mixed to a uniform consistency of stiff paste. Adjoining courses shall break joints ½ brick as nearly as practicable. The courses shall be leveled in all places except where it otherwise may be necessary for the proper adjustment of the structure. At least one course in every 7 shall be composed of headers. All brick shall be thoroughly wetted immediately before being laid. No spalls or bats shall be used except for shaping around irregular openings or when unavoidable to finish out a course. All joints shall be completely filled with mortar.

Frames for castings and cast iron bearing plates shall be set in full mortar beds composed of one part Portland cement and 2 parts sand by volume. Castings shall be set accurately to the finished elevations, so that no subsequent adjustment will be necessary.

After inspection of the completed structure by the engineer and when directed, the excavated areas which are not occupied by the completed structure shall be refilled to the required elevation with suitable material which shall be

placed in layers not more than 6 inches in depth when in a loose condition and each layer thoroughly compacted by mechanical tamping. If the backfill material is too dry to compact to the satisfaction of the engineer, it shall be wetted with water as directed.

MEASUREMENT AND PAYMENT

17.03 Method of Measurement:

Catch basins, inlets, manholes and pipe junctions adjusted will be measured by the structure and each structure adjusted will be counted.

17.04 Basis of Payment:

The number of structures adjusted, completed and accepted, measured as provided above, shall be paid for at the contract unit price each for the item applying thereto, which price and payment shall constitute full compensation for adjusting the structure in accordance with the plans or as directed by the engineer; for all excavating and backfilling; and for furnishing all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-17-1, Adjusting Catch Basins, Inlets, Pipe Junctions and Manholes, per each.
Item 5-17-2, Adjusting Catch Basins, per each.
Item 5-17-3, Adjusting Inlets, per each.
Item 5-17-4, Adjusting Pipe Junctions, per each.
Item 5-17-5, Adjusting Manholes, per each.

SECTION 18

RANDOM RIPRAP

HAND-PLACED RIPRAP

GROUTED RIPRAP

18.01 Description:

This item shall consist of a protective covering of approved stone or waste concrete, placed over such areas as are shown on the plans or as directed by the engineer and in conformity with the plans and specifications.

MATERIALS

18.02 Stone:

Riprap shall be durable field or quarry stone. It shall be dense, resistant to the action of air and water, and suitable in all respects for riprap purposes. Stone used for hand-placed riprap and grouted riprap shall be approximately rectangular in shape. The volume of the individual stones, except those used for chinking, shall be not less than ¼ of a cubic foot.

If suitable material is available, stone for riprap may be obtained within the right of way in accordance with the provisions of Article 4.06, Division I. If it is not available within the right of way, the contractor shall make his own arrangements for the purchase and delivery of the stone required.

Waste concrete may be substituted for the stone, if it is sound and meets the size requirements for stone.

18.03 Cement, Sand and Water:

These materials shall meet the requirements of Section 5, Part 4, Division II. Specific reference is made to Articles 5.03, 5.05 and 5.06.

CONSTRUCTION METHODS

18.04 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 the depth shown on the plans or specified by the engineer.

18.05 Hand-Placed Riprap:

The area over which the hand-placed riprap is to be placed shall be shaped to conform to the cross section shown on the plans or designated by the engineer. All trees, brush or stumps shall be removed to the elevation of the bed of the riprap and all loose material shall be thoroughly compacted by approved methods. When the riprap is to be laid on a slope, a trench of the required dimension shall be excavated at the toe of the slope and the stone firmly embedded in the trench at the toe thereof, with the axis of each

stone most nearly approximating the specified thickness of the riprap, laid perpendicular to the slope. All stones shall be laid in such a manner as to break joints with adjacent stone and shall be laid with the minimum practicable amount of space between them. After the stones have been laid all spaces between them shall be chinked with small stones or spalls rammed firmly into place. The finished face of the riprap shall be as smooth and true to the line, grade and section as the material will permit. Unless otherwise specified, the riprap, in place, shall have a minimum thickness of 6 inches, measured at right angles to the face of the riprap.

18.06 Grouted Riprap:

Grouted riprap shall conform to the requirements of hand-placed riprap and in addition all interstices in the stones shall be completely filled with grout throughout the entire thickness of the riprap, after which the surface shall be swept with a stiff broom. The grout shall consist of one part by volume of Portland cement, 3 parts by volume of dry sand and sufficient water to produce the desired consistency.

MEASUREMENT AND PAYMENT

18.07 Method of Measurement:

Random riprap will be measured by the cubic yard of stone in vehicles at the point of dumping on the project as specified under Article 9.01, Division I.

Hand-placed riprap will be measured by the square yard in place.

Grouted riprap will be measured by the square yard in place.

18.08 Basis of Payment:

The quantity of riprap placed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Random Riprap," "Hand-Placed Riprap" or "Grouted Riprap," as the case may be, which price and payment shall constitute full compensation for furnishing all materials, unless otherwise specified, and for placing the riprap in accordance with the plans or as directed by the engineer; for all excavation and backfilling; for furnishing

all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-18-1, Random Riprap, per cubic yard.
Item 5-18-2, Hand-Placed Riprap, per square yard.
Item 5-18-3, Grouted Riprap, per square yard.

SECTION 19

REVETMENTS

Grouted Concrete Block Revetments
Concrete Cast-in-Place Revetments
Sacked Concrete Revetments

19.01 Description:

This item shall consist of the construction of revetments of one of the types listed above, which shall be placed against the embankment and along the slopes and bottoms of stream channels at bridge ends or at other points to be protected in accordance with the plans and these specifications or as directed by the engineer.

19.02 Proportioning and Mixing:

Grouted Concrete Block and Concrete Cast-in-Place Revetments: The concrete shall be Class R, proportioned and mixed as set forth under Section 5, Part 4, Division II.

Sacked Concrete Revetments: The concrete shall be composed of one part Portland cement, 3.6 parts of fine aggregate and 5.4 parts of Grade A coarse aggregate by weight, measured separately. If the contractor desires to measure the materials by volume, the proportion by volume of the mix for each respective ingredient shall be determined by the laboratory to obtain the same yield of concrete. The mixing equipment and mixing shall comply with Articles 5.02 and 5.13, respectively, of Section 5, Part 4, Division II.

MATERIALS

19.03 Cement, Sand, Coarse Aggregate and Water:

These materials shall meet the requirements of Section 5, Part 4, Division II. Specific reference is made to Articles 5.03 to 5.07, inclusive.

19.04 Sacks:

The sacks used shall be suitable bags of burlap, or other open mesh material approved by the engineer, of 1 or 2 cubic foot capacity and uniform size. Bags which have been used as containers for sugar or chemicals shall not be used.

CONSTRUCTION METHODS

19.05 Placing:

Grouted Concrete Block Revetment: Blocks shall be of precast concrete, 12" x 24", and of the thickness shown on the plans. Unless otherwise directed, the slopes upon which concrete blocks are to be placed shall conform to the slope of the cross section of the embankment as shown on the plans. The placing of concrete blocks shall commence in a trench below the toe of the slope and shall progress upward.

Each block shall be laid by hand perpendicular to the slope, shall be firmly bedded against the slope and against adjoining blocks, and shall be laid with broken joints.

All concrete blocks shall be grouted into place. Grout shall be applied in such a manner as to insure filling all joints and crevices. Grout used shall be of the same materials, proportions and consistency as provided for grouted riprap in Article 18.06, Part 5, Division II.

Concrete Cast-in-Place Revetments: The cast-in-place revetments shall be of the thickness shown on the plans. Unless otherwise directed, the slopes upon which the revetment is to be placed shall conform to the slope of the cross section of embankment as shown on the plans. The placing of cast-in-place revetments shall commence in a trench below the toe of the slope and casting shall progress upward.

Sacked Concrete Revetments: The revetments shall be constructed of the thickness indicated on the plans.

Immediately prior to the construction or placing of the revetment covering, the embankment slopes, stream bank slopes and/or other surfaces to be protected shall be prepared to the lines and grades indicated on the plans, or as directed by the engineer, by excavating, filling, dressing, trimming and backfilling where necessary. All materials used in filling shall be thoroughly compacted by approved methods. After the earth bed on which the revetment is to be placed has been dressed and compacted to a true surface and approved by the engineer, the sacked concrete

shall be placed by hand and rammed or tamped into final location, while the concrete is still green, in such a manner as to close all crevices between bags, and cause the mortar oozing through the open mesh to form a moderate bond. On slopes, construction shall begin at the bottom of the section to be covered against a toe wall, which shall be constructed as hereinafter described. The bags of concrete shall be placed end to end, side to side, or end to side as necessary to stagger in such a manner as to provide a locked construction. They shall be so laid as to give a fairly uniform construction of the thickness specified on the plans.

The toe of the revetment at the bottom of slopes, stream channels and also the outer edges along the channel sides or slopes shall be laid against a toe wall extending 2 feet below the ground surface. This wall shall be composed of bags of concrete placed in such a manner as to form a wall 8 inches thick where a 4 inch thickness of revetment is used and 12 inches thick where a 6 inch thickness of revetment is used. Outer edges and top of the revetment not requiring heavy toe wall protection shall be formed by placing a single header row of bags of concrete on end and extending below the bottom surface of the revetment at least 6 inches. Unless otherwise provided by the plans, or directed by the engineer, the surface of the revetment where the construction terminates shall be embedded even with the surface of the slope or ground adjoining the revetment.

All revetment will be placed in the dry unless otherwise directed by the engineer.

MEASUREMENT AND PAYMENT

19.06 Method of Measurement:

Grouted Concrete Block Revetment: Concrete block revetment will be measured by the square yard and the number of square yards determined by measurement of the net area of the blocks. Four and one-half blocks will equal one square yard of block revetment in place. Toe walls and/or other projections extending from the general surface of the revetments, in the manner shown on the plans, will also be measured.

Concrete Cast-in-Place Revetment: Concrete cast-in-place revetments will be measured by the square yard, and the number of square yards will be determined by the net

area of the completed and accepted revetments. Toe walls and/or other projections extending from the general surface of a revetment, in the manner as shown on the plans, will also be measured.

Sacked Concrete Revetment: Sacked concrete revetment will be measured by the cubic yard as determined from the theoretical yield and the actual number of batches used.

19.07 Basis of Payment:

The number of units placed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Revetments," which price and payment shall constitute full compensation for preparation of embankment slopes, excavation and backfilling; for furnishing all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-19-1, Grouted Concrete Block Revetments (4" Thick), per square yard.
Item 5-19-2, Grouted Concrete Block Revetments (6" Thick), per square yard.
Item 5-19-3, Concrete Cast-in-Place Revetments (4" Thick), per square yard.
Item 5-19-4, Concrete Cast-in-Place Revetments (6" Thick), per square yard.
Item 5-19-5, Sacked Concrete Revetments, per cubic yard.

SECTION 20

CONCRETE CURBS AND GUTTERS

Plain Concrete Curb
Plain Concrete Gutter
Combination Curb and Gutter
Combination Lip Curb and Gutter
Integral Concrete Curb
Integral Concrete Lip Curb
White Reflecting Plain Curb
White Reflecting Combination Curb and Gutter
White Reflecting Integral Curb

20.01 Description:

This item shall consist of the construction of any of the types of curbs and gutters listed above in conformity

with the lines, grades, dimensions and typical sections indicated on the plans and in accordance with these specifications.

White reflecting curbs and gutters shall be constructed of grey concrete with a white scored facing on curbs constructed of white mortar or white concrete as indicated on the plans.

20.02 Composition, Proportioning and Mixing:

(a) Integral Types: All concrete for these items except the white facing for white reflecting curbs, shall be the same as provided for the roadway slab of which it shall form an integral part and shall be proportioned and mixed as set out in Section 5, Part 3, Division II.

(b) All Types Except Integral: All concrete for these items, except the white facing for white reflecting curbs, shall be Class A, proportioned and mixed as set out under Section 5, Part 4, Division II.

(c) White Concrete: White concrete shall be Class A concrete as set forth in Section 5, Part 4, Division II, except that white Portland cement and aggregates as hereinafter set forth shall be used.

(d) White Mortar: White Mortar shall be composed of one part of white Portland cement to 1¾ parts of fine aggregate by volume. The cement and fine aggregate shall be thoroughly mixed and sufficient water added to produce the required consistency and workability.

MATERIALS

20.03 Cement, Sand and Coarse Aggregate (for Grey Concrete):

These materials shall meet the requirements of Section 5, Part 4, Division II. Specific reference is made to Articles 5.03, 5.06 and 5.07.

20.04 White Portland Cement:

White Portland cement shall be white Type I meeting the requirements of the Specifications for Portland Cement, A.S.T.M. Designation: C 150.

20.05 Fine Aggregate for White Concrete and White Mortar:

Sand shall be white quartz, crushed white limestone, white marble or white granite which shall contain no discoloring material, clay, loam or other foreign matter. White quartz sand shall contain not more than 0.5 per cent of material which can be removed by elutriation. Crushed white limestone, white marble, or white granite shall contain not more than one per cent of material which can be removed by elutriation. By visual comparison fine aggregates shall be, in the opinion of the engineer, at least as white as a standard sample on file in the Department's laboratory. The gradation of fine aggregate used for white concrete and mortar shall be the same and shall comply with the requirements of fine aggregate for concrete in Article 5.06, Part 4, Division II.

20.06 Coarse Aggregate for White Concrete:

Coarse aggregate shall be light-colored gravel, limestone, or granite and shall be sound, hard, durable and free from loam, clay, organic or other foreign matter. It shall contain no more than 5 per cent of slate, shale, or soft sandstone pieces. The coarse aggregate when tested by means of laboratory sieves shall meet the following requirements:

	Per Cent
Passing ¾ inch Sieve	100
Passing ½ inch Sieve	40–75
Passing No. 4 Sieve	0–5

20.07 Water and Premoulded Filler:

These materials shall meet the requirements of Articles 5.05 and 5.08, respectively, of Part 4, Division II. Either type of premoulded filler may be furnished as the contractor elects.

20.08 Samples and Tests for White Mortar and White Concrete:

Representative samples of all materials shall be submitted by the contractor to the Department's laboratory in

sufficient quantities to permit prescribed tests and to determine if the color, strength and other qualities of the mortar or concrete for which the materials are intended are satisfactory to the engineer. The light-reflection value of the white mortar and white concrete composed of cement and aggregates used by the contractor shall be at least equal to the standard sample on file in the Department's laboratory.

CONSTRUCTION METHODS

20.09 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. When foundation underdrains are to be placed under curbing and gutter, the excavation and backfilling for same shall be completed and compacted before subgrade for curbing and gutter is prepared.

20.10 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. At least 3 stakes shall be provided for each 10 feet. Wood forms shall be minimum 2-inch S1S planks. Metal forms shall be of approved section. Forms shall be of a depth equal to the depth of the curbing or gutter, so designed as to permit of secure fastening together at the tops. The outside form shall be straight from top to bottom. The inside form shall have a batter from the top of the curbing to the finished surface line of the pavement as shown on the plans, and shall be straight from this line to the bottom. 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.

20.11 Joints:

Integral Types: Joints shall be formed in the curbing to correspond with "Dummy Joints" and other transverse joints in the pavement slab. All expansion joints shall extend entirely through the curb section and shall be finished and filled with premoulded filler.

All Types Except Integral: One-quarter inch joints shall be provided at intervals of 6 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.

20.12 Depositing Concrete (Except White Mortar or White Concrete):

Integral Types: After the concrete pavement slab has been struck off, the curb form shall be clamped or otherwise securely fastened in place upon 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.

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.

White Reflecting Curbs: When facing of white concrete or white mortar is to be used on curbs, the grey concrete shall be deposited as required in the first 2 paragraphs of this article, except as herein otherwise provided.

20.13 Finishing (Except White Reflecting Curbs):

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 wetting a wood block and rubbing the surface until it is smooth. Plenty of water shall be used, either by dipping the block in water or by throwing water on the curb or gutter with a brush.

20.14 White Mortar Construction:

(a) Preparation for and Placing of Mortar: The grey concrete shall be placed carefully so that none of it touches the forms above the required bottom elevation of the white mortar facing material. The grey concrete shall be spaded or vibrated, and struck off or screeded to the required bottom elevation of the white mortar facing. Any film or particles adhering to the forms shall be entirely removed before placing of the white mortar. The white mortar shall be placed before the grey concrete has attained its initial set in order to secure monolithic construction between the grey concrete and the white mortar. Care shall be taken that no evidence of the grey concrete is apparent on the surface of the curb.

(b) Scoring and Finishing: After the white mortar is placed, it shall be smoothly struck off or screeded to the proper elevation. The white mortar curb surface shall then be scored uniformly in accordance with the details shown on the plans, using tools and guides as indicated on the plans or approved by the engineer, care being taken to see that the scoring is smooth. As soon as the mortar begins to harden, the scoring operation shall be repeated so that the reflecting surfaces are sharp and smooth, and will require no further finishing. The curb surface shall be rounded at the upper and lower edges to the required radii by suitable edging tools as indicated on the plans or approved by the engineer. Care shall be taken in edging the curb so that mortar will not be displaced over the finished scoring. Any discoloration that may take place in the white mortar surface, either during or after the construction of the curb, shall be cleaned by rubbing with carborundum or

by any other method satisfactory to the engineer, so as to be white at the time of acceptance.

20.15 White Concrete Construction:

(a) Preparation for and Placing of White Concrete: The preparation for and placing of white concrete shall be the same as provided for white mortar in Article 20.14 (a) hereinbefore. After the grey concrete has been placed, an approved face form, properly cleaned and prepared with parting oil, shall be located firmly in proper position. The white concrete shall be placed and carefully but firmly spaded so that it will be dense throughout.

(b) Finishing of Faces and Fins: All faces and fins and all recessed surfaces of the reflecting panels shall have smooth surfaces which require no further finishing when the forms are removed. All outside edges of the reflecting surfaces shall be sharp. The curb shall be rounded at the upper edges to the required radii by suitable edging tools, and the top surfaces shall be finished smooth with a steel float and lightly brushed to remove all tool marks. After the face form is removed, any juncture marks between the face form and edging tools shall be removed by rubbing with carborundum stone, and any defects in contour and finish shall be repaired at the direction of the engineer. A grout or wash coat of neat white cement will not be permitted.

20.16 Curing (Except White Reflecting Curbs):

After finishing, the curb and/or gutter shall be cured in the same manner as provided in Section 5, Part 3, Division II, for Portland cement concrete pavement.

20.17 Curing of White Reflecting Curbs:

Immediately after the finishing operations have been completed on the white curb surfaces, the white curb shall be protected and cured by a covering of canvas supported on frames to prevent contact with the curb. After the curb has hardened sufficiently to prevent marring, a substantial waterproof paper approved by the engineer and which will not stain the white surface may be used to replace the canvas and frames. The canvas and paper shall be kept securely in place by weights and adjoining ends shall be lapped at least 18 inches. The curing shall continue for a period of not less than 48 hours, dating from the time the

curb is finished. As an alternate method of curing, the curb may be sprayed with transparent, colorless curing compound, approved by the engineer, and applied in accordance with the manufacturer's recommendations. The canvas cover shall be placed over the curb immediately after the finishing operation has been completed and shall be left in place until the curing compound can be sprayed without marring the surface of the curb.

20.18 Backfilling:

After the concrete has set sufficiently, the contractor shall backfill adjacent to the curb or gutter with suitable material which shall be compacted with mechanical tampers in layers of not more than 6 inches until firm and solid.

MEASUREMENT AND PAYMENT

20.19 Method of Measurement:

Curb and combination curb and gutter will be measured by the linear foot along the line for computing lengths indicated on the plans.

Gutter will be measured by the square yard.

20.20 Basis of Payment:

Curb and gutter placed and accepted, measured as provided above, shall be paid for at the contract price per unit of "Curb," "Gutter" and "Curb and Gutter," complete in place, which price and payment shall constitute full compensation for all necessary excavation, preparation of subgrade and backfilling and for the furnishing of all materials, forms, equipment, tools, labor, and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-20-1, Plain Concrete Curb, per linear foot.

Item 5-20-2, Plain Concrete Gutter, per square yard.

Item 5-20-3, Combination Curb and Gutter, per linear foot.

Item 5-20-4, Combination Lip Curb and Gutter, per linear foot.

Item 5-20-5, Integral Concrete Curb, per linear foot.

Item 5-20-6, Integral Concrete Lip Curb, per linear foot.
Item 5-20-7, White Reflecting Plain Curb (White Mortar), per linear foot.
Item 5-20-8, White Reflecting Combination Curb and Gutter (White Mortar), per linear foot.
Item 5-20-9, White Reflecting Integral Curb (White Mortar), per linear foot.
Item 5-20-10, White Reflecting Plain Curb (White Concrete), per linear foot.
Item 5-20-11, White Reflecting Combination Curb and Gutter (White Concrete), per linear foot.
Item 5-20-12, White Reflecting Integral Curb (White Concrete), per linear foot.

SECTION 21

SALVAGED SURFACING MATERIAL

21.01 Description:

This item shall consist of the removal of the existing surfacing material from the highway; the hauling, placing and spreading of this material on the completed and approved subgrade or shoulders, or as directed, all in accordance with these specifications and at the locations shown on the plans.

CONSTRUCTION METHODS

21.02 General:

The surfacing material that is to be removed shall be taken up to the full area and depth designated and the salvaged material stock-piled at convenient points adjacent to the roadway or hauled and placed directly on the prepared subgrade or shoulders. The salvaging operations shall be conducted so as to secure the maximum practical recovery of material and the engineer shall be the sole judge as to the depth of material to be recovered.

The salvaged material shall be hauled from stock piles, or directly from where it is removed from the existing surface, and placed upon the prepared and approved subgrade or shoulders to the full width and depth as directed by the engineer.

MEASUREMENT AND PAYMENT

21.03 Method of Measurement:

Salvaged surfacing material will be measured by the cubic yard and the quantity determined by measurement in vehicles at the point of delivery on the road, as provided in Article 9.01, Division I.

21.04 Basis of Payment:

The number of cubic yards placed and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Salvaged Surfacing Material," complete in place, which price and payment shall constitute full compensation for all loosening, excavating, loading, hauling and stock-piling; for unloading, spreading and shaping, and for the furnishing of all equipment, tools, labor and incidentals and for the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-21-1, Salvaged Surfacing Material, per cubic yard.

SECTION 22

REMOVAL OF BRIDGES AND CULVERTS

22.01 Description:

This item shall consist of dismantling and removing each old structure designated on the plans and in the proposal, and hauling and piling or disposing of all parts and materials from the old structure, all in accordance with the plans and these specifications.

CONSTRUCTION METHODS

22.02 General:

No old structure shall be removed or closed to traffic until passage of traffic has been satisfactorily provided for, either by the construction of a temporary crossing and detour, by detouring traffic over another convenient route, or by the completion and opening of the new structure. When existing structures are to be used for traffic during

construction, their removal shall not be undertaken until the new structures replacing them are opened to traffic.

Steel superstructures shall be dismantled and removed in a condition suitable for re-erection unless otherwise provided. The work of disconnecting, removing, handling, hauling and piling of the members and parts shall be done by such methods and equipment that the steel will not be bent, distorted, or injured in any way. In the event the materials are damaged in any way, such members shall be repaired or replaced at the expense of the contractor. Small parts, such as pins, bolts, loose plates, fillers, packing, etc., shall be securely fastened to one of the members to which they belong or connect. When required, all members and parts shall be marked and all joints match-marked and a diagram showing this marking shall be furnished to the engineer.

Substructures shall be removed to such an extent that no portions of them will remain above the stream bed or ground surface or interfere in any way with the new work. Blasting or other removal operations shall be so conducted that the new work will not be endangered or harmed in any way.

Timber which is salvageable shall be removed without undue splitting or breakage. All rotten or unsalvageable timber shall be burned or otherwise disposed of.

All steel and all salvageable timber or other materials removed from old structures shall be stored above the ground on skids or other supports in a neat and presentable manner, in locations designated by the engineer, within the right of way and adjacent to the site of the work.

All concrete and masonry removed from old structures shall be placed in backfills or approach embankments, or be used to riprap the slopes of the embankments or the channel if so specified on the plans, or as directed by the engineer. Any concrete or masonry which can not be placed in the backfills or embankments or used as riprap shall be disposed of in such manner as to avoid damage to property or the creation of unsightly conditions.

The contractor shall not make use of any materials or parts from old structures without the written permission of the engineer, and any materials and parts so used shall be left in substantially the same condition in which they were removed from the old structure.

MEASUREMENT AND PAYMENT

22.03 Method of Measurement:

Measurement of Each Structure as Separate Unit: Each old structure to be removed shall be designated on the plans and in the contract by its station number and for the purpose of measurement will be considered a complete and separate unit.

Measurement of Structures Collectively: The unit of measure shall be the structure and each structure actually removed shall be counted.

22.04 Basis of Payment:

The number of old structures removed, measured as provided above, shall be paid for at the contract unit price for each structure removed, which price and payment shall constitute full compensation for the furnishing of all equipment, tools, falsework, labor and incidentals, and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-22-1, Removal of Bridges, per structure.
Item 5-22-2, Removal of Bridges, per each.
Item 5-22-3, Removal of Culverts, per structure.
Item 5-22-4, Removal of Culverts, per each.

SECTION 23

REMOVING OLD PAVEMENT, CURB, CURB AND GUTTER, GUTTER AND WALKS

23.01 Description:

This item shall consist of removing old pavement (surface and base course), curb, combination curb and gutter, gutter and walks and disposing of same in accordance with the plans and these specifications.

CONSTRUCTION METHODS

23.02 General:

Where old pavement, gutter or walk to be removed is of concrete and where the old curb or combination curb and gutter is of concrete and is not to be salvaged, the concrete

shall be broken into riprap of a size easily handled by one man and placed around the ends of drainage structures as indicated on the plans or otherwise disposed of all as directed by the engineer. Pavement, curb, combination curb and gutter, gutter and walks other than of concrete shall be removed in a satisfactory manner and the materials salvaged or disposed of as directed by the engineer. Materials having no salvage value may be disposed of in embankments if suitable and if permitted by the engineer. Where a portion of the old pavement, curb, combination curb and gutter, gutter or walk is to be left in place, the removed portion shall extend to an existing joint or shall be cut to a true line with a vertical face. Sufficient removal shall be made to provide for proper grades and connections with the new work.

If the existing curb or combination curb and gutter is in sections and is to be salvaged, it shall be taken up in sections without unnecessary breakage, stored beyond the limits of construction or reset in the new location as required.

MEASUREMENT AND PAYMENT

23.03 Method of Measurement:

Removing old pavement, gutter and walks will be measured by the square yard and the areas to be measured shall be the actual area of old pavement, gutter or walks removed.

Removing old curb and old combination curb and gutter will be measured by the linear foot along the face of the curb and along the wearing surface of the road or along the surface of the gutter as the case may be. The length for measurement shall be the actual length removed.

23.04 Basis of Payment:

The number of square yards of old pavement, gutter or walk removed, and the number of linear feet of curb or combination curb and gutter removed, as required by the plans or as directed by the engineer, measured as provided above, shall be paid for at the contract unit price for the item applying thereto, which price and payment shall constitute full compensation for removing the pavement, curb, combination curb and gutter, gutter or walk, breaking up concrete and placing same as riprap, salvaging and disposing of all resulting materials as directed by the engineer, and

all hauling and other work in connection therewith; the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-23-1, Removing Old Pavement, per square yard.
Item 5-23-2, Removing Old Gutter, per square yard.
Item 5-23-3, Removing Old Walk, per square yard.
Item 5-23-4, Removing Old Curb, per linear foot.
Item 5-23-5, Removing Old Combination Curb and Gutter, per linear foot.

SECTION 24

PLAIN PORTLAND CEMENT CONCRETE WALKS

24.01 Description:

This item shall consist of the construction of concrete walks in one course on the prepared subgrade in conformity with the lines, grades, thickness and cross sections shown on the plans and in accordance with these specifications.

24.02 Proportioning and Mixing:

All concrete for this item shall be Class A, proportioned and mixed as set out under Section 5, Part 4, Division II.

MATERIALS

24.03 Cement, Sand, Coarse Aggregate, Water and Premoulded Filler:

These materials shall meet the requirements of Section 5, Part 4, Division II. Specific reference is made to Articles 5.03 to 5.08, inclusive. Either type of premoulded filler may be furnished as the contractor elects.

CONSTRUCTION METHODS

24.04 Subgrade:

The subgrade shall be constructed as provided in Article 4.12, Part 1, Division II, of these specifications insofar as

applicable hereto. The sidewalk area shall be rolled at the same time that the subgrade for the surface course is rolled. All areas inaccessible to a power driven roller shall be thoroughly compacted by means of approved mechanical tampers.

24.05 Forms:

The forms shall be of either metal or wood and shall be straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the walks. Wood forms shall have a minimum thickness of 2 inches. Metal forms shall be of a type approved by the engineer. The forms shall be thoroughly cleaned, well oiled, securely staked, braced and held to the required line and grade before any concrete is deposited.

24.06 Depositing and Finishing Concrete:

The concrete shall be deposited between the forms on the moistened subgrade and shall be struck off and compacted to the required thickness. It shall be tamped sufficiently to bring the mortar to the top 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.

24.07 Joints:

The walks shall be marked in sections approximately square, or of such dimensions as are indicated on the plans or directed by the engineer. Three-fourths inch expansion joints shall be placed at intervals not to exceed 32 feet and at all junctions of new walks with drives, curbs, buildings, structures and old walks and same filled with premoulded filler ¾ of an inch thick.

24.08 Curing:

The walks shall be cured in the same manner as provided in Section 5, Part 3, Division II for concrete pavement.

24.09 Backfilling:

After the concrete has set sufficiently, the forms shall be removed and the space adjacent to the walks shall be backfilled with suitable material, which shall be firmly compacted and neatly graded.

MEASUREMENT AND PAYMENT

24.10 Method of Measurement:

Concrete walks will be measured by the square yard.

24.11 Basis of Payment:

The number of square yards of completed and accepted walks, measured as provided above, shall be paid for at the contract unit price per square yard for "Walks," complete in place, which price and payment shall constitute full compensation for preparing the subgrade; for furnishing all materials; and for furnishing all forms, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-24-1, Portland Cement Concrete Walk, 4" thick, per square yard.
Item 5-24-2, Portland Cement Concrete Walk, 5" thick, per square yard.
Item 5-24-3, Portland Cement Concrete Walk, 6" thick, per square yard.
Item 5-24-4, Portland Cement Concrete Walk, 7" thick, per square yard.
Item 5-24-5, Portland Cement Concrete Walk, 8" thick, per square yard.

SECTION 25

PULLING AND REDRIVING WELLS

25.01 General:

This item shall consist of pulling pipe wells and redriving them at the locations shown on the plans or as directed by the engineer and shall be done in conformity with the plans and in accordance with these specifications. Work under this item will be limited to the type of wells which have been installed by driving.

CONSTRUCTION METHODS

25.02 General:

The pumps and fittings shall be disconnected, the pipe pulled, removed to the new location and redriven, the pumps and fittings replaced and reconnected and the wells left in as good condition in all respects as they were before they were moved. Any new pipe, pipe fittings and pump parts that may be necessary for the proper functioning of the well in its new location shall be furnished by the contractor without additional compensation.

The well in its new location shall conform to the Sanitary Code of the State of Louisiana as prepared and promulgated by the Louisiana State Board of Health.

The contractor will be required to furnish a certificate of release from the property owner as specified in Article 28.02, Part 5, Division II.

MEASUREMENT AND PAYMENT

25.03 Method of Measurement:

Pulling and redriving wells will be measured by the well and each well pulled and redriven will be counted.

25.04 Basis of Payment:

The number of wells pulled, redriven and accepted, measured as provided above, shall be paid for at the contract unit price per well for "Pulling and Redriving Wells," complete in place, which price and payment shall constitute full compensation for pulling the pipes, moving to new locations and redriving, for all disconnecting and reconnecting pipe, pipe fittings and pump, for any necessary new parts and for the furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-25-1, Pulling and Redriving Wells, per well.

SECTION 26

CONSTRUCTING WELLS

26.01 Description:

This item shall consist of the construction of new wells, dug or drilled as indicated, at the location shown on the

plans or as directed by the engineer to replace existing wells. It shall include filling old dug wells and/or the removal or cutting off of old drilled wells. All work shall be done in conformity with the plans and in accordance with these specifications.

CONSTRUCTION METHODS

26.02 General:

Wells shall be constructed of the same size as the ones they replace. Upon completion of all work the contractor will be required to furnish a certificate of release from the property owner as specified in Article 28.02, Part 5, Division II.

New water wells shall conform to the Sanitary Code of the State of Louisiana as prepared and promulgated by the Louisiana State Board of Health.

(a) Dug Wells: The wells shall be lined or cased with material of the same type or character as the linings or casings in the existing wells. Material salvaged from the old wells may be used in the new wells, provided this material is salvaged in a usable condition, but any new material required shall be furnished by the contractor without additional compensation.

The new well shall be dug to such a depth that its supply of water will be equal in quantity to that of the well which it replaces, and the new well shall be equal in all respects to the well which it replaces.

Materials secured in digging the new well may be used to fill the existing well. Any excess materials shall be disposed of in a satisfactory manner. Any additional materials required to fill the old well shall be secured as "Excavation" and paid for under the items applying in accordance with the applicable requirements of Section 4, Part 1, Division II.

(b) Drilled Wells: Pipe casings, well screen, and all other materials furnished for the new well shall be of the same type or character as that in the existing well. Material salvaged from the old well may used in the new well, provided such material is salvaged in a usable condition. Any new materials required shall be furnished by the contractor without additional compensation.

The new well shall be drilled to such depth that the supply of water delivered will be equal to that of the old well, and the new well shall be equal in all respects to the well which it replaces.

The old well shall be pulled and all materials satisfactorily disposed of or it shall be cut off one foot below ground line and satisfactorily plugged.

Upon completion of work, the contractor shall clean up the site, fill in slush pits and leave the site in the same condition as he found it.

MEASUREMENT AND PAYMENT

26.03 Method of Measurement:

Constructing wells will be measured by the well and the number of wells constructed will be counted.

26.04 Basis of Payment:

The number of wells constructed and accepted, measured as provided above, shall be paid for at the contract unit price per well for "Constructing Wells," complete in place, which price and payment shall constitute full compensation for all drilling and excavation, for lining and casing the new wells, for the furnishing of all new materials, equipment, tools, labor and incidentals, and the performance of all work necessary to complete the item.

Additional material required to fill old wells will be paid for as "Excavation" under the items applying as provided under Article 4.15, Part 1, Division II.

Payment will be made under:

Item 5-26-1, Constructing Dug Wells, per well.
Item 5-26-2, Constructing Drilled Wells, per well.

SECTION 27

RAILROAD GRADE CROSSINGS

Creosoted Plank Railroad Grade Crossing
Reinforced Concrete Railroad Grade Crossing

27.01 Description:

This item shall consist of the construction of one of the types of railroad grade crossings listed above, complete in place, in accordance with the plans and specifications and as directed by the engineer.

MATERIALS

27.02 Hardware:

All hardware shall be black. Lag screws may be either wrought iron or medium steel. Tie plates and rail spikes shall meet the specifications of the Railway Company.

27.03 Lumber:

Planks, as shown on the plans, shall be creosoted red gum, No. 1 Common, meeting the gradation requirements of the National Hardwood Lumber Association. Red gum shall be creosoted with an 8 pound treatment in accordance with the requirements of Section 3, Part 5, Division II.

Shims, as shown on the plans shall be either creosoted gum, meeting the above requirements, or creosoted southern pine meeting the applicable requirements of Section 8, Part 4, Division II.

All crossties furnished shall be creosoted southern pine conforming to the applicable requirements of Section 8, Part 4, Division II.

27.04 Ballast:

Ballast shall conform to the requirements for Washed Sand Gravel, Article 2.05, Part 2, Division II.

27.05 Concrete:

Concrete shall be Class A meeting the applicable requirements of Section 5, Part 4, Division II.

27.06 Reinforcing Steel:

Reinforcing steel and tie rods shall be deformed bars conforming to the requirements of Article 6.02, Part 4, Division II.

27.07 Fabric Reinforcement:

Fabric reinforcement where required shall conform to the requirements of Article 6.03, Part 4, Division II.

CONSTRUCTION METHODS

27.08 General:

In the prosecution of this contract, the contractor shall, except as otherwise provided herein, sublet all work to be

performed in connection with the railroad grade crossing, to the railroad company and shall permit the railroad company to perform such other work as is required by this contract to be performed within the limits of the railroad company's right of way as deemed advisable by said company for the protection of their interests. The contractor shall reimburse the railroad company for all work undertaken by the railroad company pursuant to this agreement. If agreeable to the railroad company, the contractor may perform any and all work to be done under this contract within the railroad company's right of way with his own forces, provided a satisfactory agreement has been reached with the railroad company. No work shall be commenced within the railroad company's right of way until the Department has been advised in writing by the railroad company that a satisfactory agreement has been reached and that the contractor has complied with all of the railroad company's requirements.

All work performed by the contractor shall be done in strict compliance with railroad standards of construction.

Ballast shall be placed under and around ties in sufficient amount to insure the stability of the rails.

MEASUREMENT AND PAYMENT

27.09 Method of Measurement:

Creosoted plank railroad grade crossings will be measured by the square foot, and the area to be measured shall be the area bounded by the outer limits of the creosoted plank.

The reinforced concrete grade crossings will be measured by the square yard and the area to be measured shall be the area bounded by the outer limits of the concrete.

27.10 Basis of Payment:

Grade crossings, completed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Railroad Grade Crossings," complete in place, which price and payment shall constitute full compensation for furnishing all materials (except rails, tie plates, or other rail hardware), equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-27-1, Creosoted Plank Railroad Grade Crossing, per square foot.

Item 5-27-2, Reinforced Concrete Railroad Grade Crossing, per square yard.

SECTION 28

REMOVAL AND RELOCATION OF BUILDINGS AND MISCELLANNEOUS STRUCTURES

MOVING OF BUILDINGS AND MISCELLANEOUS STRUCTURES

28.01 Description:

The removing and relocation of buildings and miscellaneous structures shall consist of the removal, preparation for moving and relocation of buildings or structures of all types, together with all service connections, appurtenances and accessories; reconstruction of all foundations and appurtenances, all in accordance with the plans and these specifications.

Moving of buildings and miscellaneous structures shall consist of moving units specified under the item "Removal and Relocation of Buildings and Miscellaneous Structures" from the original location to the final location. This item shall include the extension of water, gas, sewer and other service lines and utilities and all materials necessary therefor.

CONSTRUCTION METHODS

28.02 General:

The Department reserves the right to eliminate from the work to be done by the contractor, the removal of any or all of the buildings, structures, etc., itemized under these items, if deemed advisable by the engineer. Such elimination shall not affect the unit prices bid on the remaining buildings, structures, etc., to be moved, or the unit prices bid on the other items of the contract and the contractor will not be entitled to any compensation due to such elimination.

(a) Removal and Relocation of Buildings and Miscellaneous Structures: Buildings or structures shall be prepared for moving, removed and placed in their new loca-

tions, as shown on the plans or as designated by the engineer, 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 foundation.

Steps, outside stairways, canopies, porches, block or post supports, sills, chimneys on brackets and other appurtenances forming an integral part of the building are to be considered as part of the building and removed and relocated 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 building but not movable as an integral part of the building, shall be removed, relocated and/or replaced with foundations or appurtenances of the same size, type and character as existed before the building 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 building or 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 the new locations designated by the engineer. All of the above shall be considered as appurtenances and appliances to the buildings or 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 building, 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 appurtenance shall be removed and disposed of as directed by the engineer.

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 buildings or structures shall be removed and relocated along with the building or structure to its new site. In the event that it is not feasible or possible to remove the building or structure together with the contents therein, the contents shall be removed from the building or structure at its original location and same replaced in the relocated building or structure. Such precautions as necessary shall be taken to prevent damage or loss of any kind to the contents thereof.

The contractor shall furnish the Department with a certificate of release from each property owner, and in the event of separate ownership of building and property, a certificate of release from each owner shall be furnished. This certificate shall state that the buildings or structures removed and relocated are in an acceptable condition and that said owner waives all claims for damages to his property and buildings or structures removed.

(b) Moving of Buildings and Miscellaneous Structures: The limits of moving of a building unit shall be the distance from the center of the principal building or structure in its original location, measured along the shortest practical route of moving to the center of the principal building or structure in its new location. Appurtenances to the principal building or structure will not be considered in the measurement, but shall be moved with the principal building or structure as a unit and re-established at the new location.

MEASUREMENT AND PAYMENT

28.03 Method of Measurement:

Removal and relocation of buildings and structures will be measured by the building or structure designated on the plans and each principal building or structure will be designated on the plans and in the contract by its station number and for the purpose of measurement, each principal building or structure, together with its appurtenances and appliances will be considered a complete and separate unit.

The moving of a building unit shall be measured in units of principal building or structure moved one foot which shall be designated as "building foot."

28.04 Basis of Payment:

Buildings removed, moved, relocated and accepted, measured as provided above, shall be paid for at the contract unit price for "Removal and Relocation of Buildings and Miscellaneous Structures" and "Moving of Buildings and Miscellaneous Structures," which price and payment shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-28-1, Removal and Relocation of Buildings and Miscellaneous Structures, per unit.

Item 5-28-2, Moving of Buildings and Miscellaneous Structures, per building foot.

DIVISION III

Design of Structures

(Current A.A.S.H.O. Standard Specifications for Highway Bridges unless otherwise indicated on plans.)

DIVISION IV

Design of Movable Bridges

(Current A.A.S.H.O. Standard Specifications for Movable Highway Bridges unless otherwise indicated on plans.)

DIVISION V

Contract Documentary Forms

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DIVISION V

NOTICE TO CONTRACTORS

Sealed proposals for the construction of the following project will be received by the Louisiana Department of Highways, ..., Baton Rouge, Louisiana, until ..... After ....., proposals will be received in ..... until ..... No proposals will be received after ..... At ..... of the same day and date they will be publicly opened and publicly read in .....

(Description of Project and other pertinent information to be placed here.)

Full information and proposal forms are available at the offices of the Department of Highways, at Baton Rouge. Plans and specifications may be inspected at said office or at the Department's District office at....., Louisiana, or plans will be furnished upon payment of $..... (not to be refunded). Upon request of the bidder, the District Engineer at....., Louisiana, or his qualified representative, will show the work.

Bids must be submitted on proposal forms provided by the Department.

The Department of Highways reserves the right to reject any or all proposals.

DEPARTMENT OF HIGHWAYS

....., Director

STATE OF LOUISIANA
DEPARTMENT OF HIGHWAYS

CONSTRUCTION PROPOSAL

STATE PROJECT NO.....

.....

Proposals will be received up to ..... on .....

.....

by the Department of Highways, ..., Baton Rouge, Louisiana. After ....., proposals will be received in ....., until .....

No proposals will be received after ..... At ..... of the same day and date, they will be publicly opened and publicly read in .....

BID OF .....

ADDRESS .....

DATE ....., 19.....

To the Department of Highways,
Baton Rouge, Louisiana.

Gentlemen:

I (We) hereby agree to perform all the work known and described by you as:

State Project No. .....
entitled .....
Route No. ....., Parish.....,
consisting of ..... miles of .....
.....
....., located as follows:

(Description of location to be placed here.)

The specifications, contract and bonds, governing the construction of the work contemplated are those known and designated as Louisiana Standard Specifications for Roads and Bridges, approved by the Board of Highways.....
....., together with the "Special Provisions," if any, attached to this proposal.

The plans herein referred to are the plans approved by the Chief Engineer and marked with the project number, route and Parish, set out above, together with all standard or special designs that may be designated in such plans.

The undersigned, as bidder, declares that the only persons or parties interested in this proposal as principals are those named herein; that this proposal is made without collusion or combination of any kind or character with any other person, firm, association, or corporation, or any member or officer thereof; that he has (or they have) carefully examined the site of the proposed work, the plans, Standard Specifications and special provisions above mentioned, and the form of contract and contract bond; that he (or they) proposes, and agrees, if this proposal is accepted, to provide all necessary machinery, tools, apparatus, and other means of construction, and will do all the work and furnish all the materials specified in the contract, in the manner and time therein prescribed and in accordance with the requirements of the engineer as therein set forth; and that he (or they) hereby proposes to accept as full compensation therefor, the amount of the summation of the products of the quantities of work and material actually incorporated in the completed project, as determined by the engineer, multiplied by the respective unit prices herein bid.

It is understood by the undersigned that the quantities given in the following itemized proposal are a fair approximation of the amount of work to be done, and that the sum of the products of the approximate quantities multiplied by the unit price bid shall constitute gross sum bid, which sum shall be used in the comparison of bids, and the awarding of the contract.

The undersigned further proposes to perform all extra and force account work that may be required on the basis provided in the specifications, to give such work his personal attention and to secure economical performance.

The undersigned further agrees that within ten days after notice of the award of the contract to undersigned, he (or they) will execute the contract and furnish to the Department of Highways a satisfactory surety bond in a sum equal to the contract price as provided in the Standard Specifications.

The undersigned further agrees that work will begin not later than ten calendar days after the date of the Work Order, and shall be diligently prosecuted at such rate and in such manner as, in the opinion of the Chief Engineer, is necessary for the completion of the work within the time specified in the contract, it being understood that time is the essence of the contract.

Accompanying this proposal is a certified check in the amount of..... Dollars ($.....), payable to the "Louisiana Department of Highways." If this proposal shall be accepted and the undersigned shall fail to execute the contract and furnish bond as above provided, then the certified check shall become the property of the State, otherwise, the said check shall be returned to the undersigned. The check of the lowest bidder will be retained until after the bidder to whom the award is made has entered into the contract and has given an acceptable bond. All other checks will be returned to the bidders immediately after the amounts of the bids have been determined, compared and the results of such comparisons have been considered by the Department.

Respectfully submitted,

(If a Firm or Individual)

SIGNATURE OF BIDDER.....(Seal)

By:.....

.....

ADDRESS OF BIDDER .....

.....

Names and Addresses of Members of the Firm

.....

.....

.....

.....

(If a Corporation)

SIGNATURE OF BIDDER .....(Seal)

By:.....

.....

Names and Business Addresses of Officers

President.....

.....

Secretary.....

.....

Treasurer.....

.....

Legal Domicile.....

Return Certified Check to:.....

.....

STATE OF LOUISIANA
DEPARTMENT OF HIGHWAYS

CONTRACT

This Agreement, made and executed in ..... (.....) original copies, on this ..... day of the month of ..... in the year of our Lord, one thousand, nine hundred and ....., by and between the Department of Highways, acting by and through ...., Director of Highways, the Party of the First Part, and hereinafter designated as "Department," and ...., Contractor, domiciled and doing business in ...., Party of the Second Part, and hereinafter designated as "Contractor."

WITNESSETH, That, in consideration of the covenants and agreements herein contained, to be performed by the parties hereto and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The Contractor shall and will provide and furnish all materials, equipment and labor and perform the work re-

quired to build, construct and complete in a thorough and workmanlike manner, to the satisfaction of the Chief Engineer of the Department of Highways ..... Project No. .....
.....
entitled .....,
Route ..... No. ....., Parish .....,
consisting of ..... miles of .....
....., located as follows:

(Description of location to be placed here.)

in accordance with the plans, on file in the Office of the Department at Baton Rouge, Louisiana, dated ....., and with Louisiana Standard Specifications for Roads and Bridges approved by the Board of Highways .....,
and with the proposal filed with the Department dated .....
....., and with the Special Provisions accompanying said Proposal; copy of said Plans, Specifications and Proposal which are made a part hereof as fully as if set out herein, and hereby become a part of this contract.

It is agreed and understood between the parties hereto that the contractor agrees to accept and the Department agrees to pay for the work at the prices stipulated in said Proposal, such payment to be in lawful money of the United States, and the payment shall be made at the time and in the manner set forth in the Specifications.

Performance will begin within ten calendar days after date of the work order and shall be completed within .....
..... contract days from that date subject to such extensions as may be authorized by the terms of Article 8.08, Division I of the Specifications.

Total cost of Items Nos. .....
.....
.....
.....
.....
.....
.....
is .....
..... Dollars ($.....).

This contract shall become effective immediately upon, and as of the date, all necessary parties hereto have approached and signed the same.

IN WITNESS WHEREOF, The Director of Highways has hereunto subscribed his name, and the same has been duly approved by the Chief Engineer of the Department of Highways, and .....,
Contractor, has also hereunto subscribed his name on the days and dates set forth after their various signatures.

WITNESSES:

..... (Seal)
Contractor

.....

By: .....

.....

on ..... 19.....

STATE OF LOUISIANA
DEPARTMENT OF HIGHWAYS

.....

By: .....
Director

.....

on ..... 19.....

Approved By: .....
Chief Engineer

on ..... 19.....

STATE OF LOUISIANA
DEPARTMENT OF HIGHWAYS

CONTRACTOR'S BOND

KNOW ALL MEN BY THIS INSTRUMENT, That we
.....
.....
.....
as principal, and the .....,
a Surety Company authorized to do business in the State of Louisiana, as Surety, are held and firmly bound, in solido, unto the Department of Highways, and unto all subcontractors, workmen, laborers, mechanics, and furnishers of

materials and equipment, jointly in the full sum of.....
.....
Dollars ($.....), payable in lawful money of the United States, and to this bond we obligate our heirs, successors and assigns.

Now the consideration of this bond is such, that if the said ....., Contractor, shall well and truly perform ..... contract, made and entered into on this ..... day of ....., 19....., to construct ..... Project No. ...., entitled ....., Route ..... No. ....., Parish....., consisting of.....miles of..... ....., according to the stipulations recited in said contract, attached hereto and made a part thereof, and shall pay all sums due on materials and supplies used and for wages earned by laborers and workmen employed upon the work to be done, and if the above bonded..... shall in all things stand to and abide by and well and truly observe, to keep and perform all and singular the terms, covenants, conditions, guarantees and agreements in said contract to be observed, kept, done and performed, and each of them, at the time and in the manner and form therein specified, and shall do and perform all the labor and work and shall furnish all the materials as specified in said contract in strict accordance with all the terms of said contract and the plans and specifications thereto attached and made a part thereof, and shall indemnify and save harmless said Department of Highways against any loss or damage of whatever kind and character arising or occasioned by deeds of negligence of said principal, his agents, servants and employees in the prosecution of the work, or by reason of improper safeguards or incomplete protection to the work and shall pay all bills for materials and labor entered into the construction of said work or used in the course of the performance of the work, then this obligation shall be null and void; otherwise to remain in full force and effect.

In faith whereof, we have subscribed this obligation at Baton Rouge, Louisiana.

WITNESS OUR HANDS AND SEALS, This ..... day of ....., 19 .....

WITNESSES
As to Principal:

....
Principal

..... By: .....

WITNESSES
As to Surety:

....
Surety

..... By: ..... (Seal)
Attorney-in-Fact

Countersigned

By: ..... (Seal)
Resident Agent

REQUEST FOR PERMISSION TO SUBLET

In the event a contractor desires to sublet certain items, in accordance with the specifications and provisions relating to "Subletting," the contractor or bidder (if it is the bidder's intention, at the time his bid is submitted, to sublet certain items) shall address a letter in the following form to the Chief Engineer of the Department of Highways requesting permission to sublet the items which it is desired to sublet and attach thereto the required list of equipment.

DIVISION V

FORM OF REQUEST TO SUBLET

Date.....

State Project No.....
Name of Highway.....
Parish.....
Chief Engineer
Department of Highways
Baton Rouge, Louisiana

Dear Sir:

I desire to sublet the following items of work included in the above captioned project;

.....
.....
.....
.....

to .....
whose address is .....

The proposed subcontractor is a contractor of recognized standing with a satisfactory performance record and with an organization particularly experienced and equipped to perform the proposed work.

Attached is a list of equipment that the said proposed subcontractor proposes to use in the event that he performs the work hereinabove set forth.

All work to be performed by the said proposed subcontractor shall be done in full compliance with all applicable terms of the Department's contract and assurance is hereby given that the minimum wage for labor as stated in my proposal shall apply to labor performed on all work sublet.

It is fully understood that written consent to sublet the items of work covered by this request shall not be construed to relieve me of any responsibility for the fulfillment of the contract.

Should you desire the proposed subcontractor to submit to you a questionnaire to establish his experience and financial ability, please so advise me.

Very truly yours,

.....
Name of firm, individual or corporation

By: .....
Title

NOTE: A certificate of consent must accompany the use of the name of any proposed subcontractor. Such a certificate may be in the form of a letter addressed to the Chief Engineer of the Department of Highways and signed by the proposed subcontractor, containing the following clauses:

"This is to certify that the request of .....
in connection with State Project No. .....
.....
to sublet the following items of work to the undersigned has been made with the full knowledge and consent of the undersigned.

(List here Items of Work)

.....
.....
.....
.....

I will furnish such additional statements as you may require to determine my qualifications and ability to perform the work.

Signed: .....
Proposed Subcontractor

By: .....

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