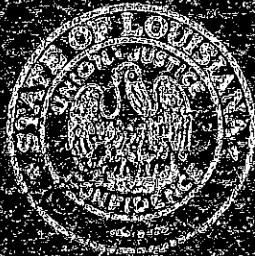


LOUISIANA  
STANDARD  
SPECIFICATIONS  
FOR  
ROADS AND BRIDGES



LOUISIANA  
HIGHWAY COMMISSION  
BATON ROUGE

\*\*\*\*\*  
MARCH 1, 1940

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STANDARD SPECIFICATIONS  
FOR  
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BATON ROUGE

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## Foreword

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

Division II is subdivided into Parts. Each Part covers certain specific items for which payment will be made if the items are included in the proposal and contract. Division II is specific in nature and the Parts, Sections and Items therein apply only when a specific reference is made thereto in the contract. Division II embraces all pay items provided for in the Standard Specifications and the item numbers used denote the "Part," the "Section" and "Identifying Numbers" applying and in the order shown. Pay items appearing in the plans, proposal and contract for which no corresponding "section" or "identifying numbers" appear in the Standard Specifications are special items and are covered fully in the special provisions. Special provisions modifying or changing the Standard Specifications will be appropriately referenced.

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**DIVISION I**  
**GENERAL REQUIREMENTS**  
**AND COVENANTS**

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## 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 State:**

The State of Louisiana.

**1.03 Commission:**

Louisiana Highway Commission, acting directly or through the State Highway Engineer.

**1.04 Chairman:**

Chairman, Louisiana Highway Commission.

**1.05 Engineer:**

The State Highway Engineer, Louisiana Highway Commission, or his authorized representative, limited by the particular duties entrusted to him. When the term "State Highway Engineer" is used, it shall mean the State Highway Engineer in person.

**1.06 Resident Engineer:**

An engineer in charge of one or more specific projects.

**1.07 Inspector:**

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

**1.08 Laboratory:**

The official testing laboratories of the Commission or such other laboratories as may be designated by the State Highway Engineer.

**1.09 Bidder:**

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

**1.10 Contractor:**

The individual, firm or corporation who enters into a contract awarded him by the Commission. The contractor may act directly or through an authorized lawful agent or employee.

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### 1.11 Subcontractor:

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

### 1.12 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.

### 1.13 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.

### 1.14 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 Commission, if the contract is awarded to him.

### 1.15 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.

### 1.16 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.

### 1.17 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

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estimate but not thoroughly or satisfactorily stipulated or set forth by the Standard Specifications.

### **1.18 Contract:**

The written agreement between the Commission and the contractor covering the performance of the work and the furnishing of labor, materials, tools, equipment and incidentals necessary for the completion of the 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.

### **1.19 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.

### **1.20 Supplemental Agreement:**

A written agreement between the Commission and the contractor, with the assent of the contractor's surety, which when duly executed becomes a part of the contract.

### **1.21 Extra Work Order:**

A written agreement on an approved form signed by the contractor and the State Highway Engineer, involving changes or additional work within the provisions of the contract and not considered of sufficient importance to require a "Supplemental Agreement."

### **1.22 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.

### **1.23 Highway:**

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

### **1.24 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.

## DIVISION I

### 1.25 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."

### 1.26 Subgrade:

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.

### 1.27 Pavement:

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

### 1.28 Shoulders:

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

### 1.29 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.

### 1.30 Bridges:

Any structure, including multiple spans, of over twenty 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.

### 1.31 Culverts:

All waterway structures not defined as bridges.

### 1.32 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.

### 1.33 Bridge Complete:

The entire structure, including both substructure and superstructure.

### 1.34 Substructure:

All of that part of the structure below the bridge seats or



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below the spring lines of arches. Parapets, backwalls and wingwalls of abutments shall be considered as parts of the substructure.

### **1.35 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.

### **1.36 The Work:**

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

### **1.37 Work Order:**

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

### **1.38 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.

### **1.39 Project Number:**

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

### **1.40 Equipment:**

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

### **1.41 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.

### **1.42 A. A. S. H. O.:**

American Association of State Highway Officials.

### **1.43 A. S. T. M.:**

American Society of Testing Materials.

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### 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 Commission 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; and instructions to bidders as to access to plans, specifications and proposals.

##### 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 forms 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

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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

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or style, corporate or otherwise, other than the real name or names of the individual or individuals conducting or transacting such business, the Louisiana Highway Commission must 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 five per cent of the correct total amount of the highest combination for which a bid is submitted. Only certified checks will be accepted as the bidders' guaranty with his proposal; any deviation 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 Highway Commission 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 Commission. 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 Commission and should preferably be registered. If submitted

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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 Commission 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 withdraw his proposal provided the request in writing is in the hands of the State Highway Engineer by the time set for opening proposals. The withdrawal of a bid shall not prejudice the right of a bidder to file a new bid.

### **2.10 Public Opening of Proposal:**

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

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with the Commission. Each prospective bidder shall file with the Commission, on forms furnished by the Commission, 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 six months after the close of their fiscal year. The balance sheet shall be properly certified on forms furnished by the Commission.

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

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

Bidders will also be required to submit a list of equipment that they propose to use on each project on which a bid is submitted.

### 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

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right is reserved to reject any and all proposals and to waive technicalities when, in the opinion of the State Highway Engineer, the best interest of the Commission 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 State Highway 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 thirty 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 ten days after notice is issued.

### **3.03 Return of Proposal Guaranties:**

All proposal guaranties, except those of the two lowest bidders, will be returned to the bidders immediately after the amounts of the bids have been determined, compared and the results of such comparison have been considered by the Commission; the others will be retained until the execution of the contract and approval of the bond, after which they will be immediately returned.

Should no award be made within thirty days, all proposals will be rejected, and all guaranties returned, unless the successful bidder agrees to a longer delay.

### **3.04 Requirement of Contract Bond:**

The successful bidder, at the time of the execution of the contract, must deposit with the Commission the bond of a surety company acceptable to the Commission 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 Commission.

### **3.05 Execution of Contract:**

The successful bidder will be required to execute the contract and furnish bond satisfactory to the Commission within



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ten 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 Commission 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 Commission. 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 ten days after notice has been given the bidder by the Commission of the award, the right is reserved by the Commission 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 ten days above specified, the "Proposal Guaranty" accompanying his bid shall become the property of the Commission.

## 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.

## DIVISION I

### 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 actual cost of any items which, in cost, is originally ten per cent or more of the total cost of the contract, overruns or underruns ten per cent; or if the algebraic sum of the cost of two or more items overruns or underruns the total cost of the contract as much as twenty-five per cent, a supplemental agreement shall be executed, covering revised contract consideration agreed upon for such items.

### 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. The Commission shall not extend the project.

### 4.05 Traffic:

Definition of Through and Local Traffic: 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.

Local traffic is that traffic emanating from without the limits of the project and having as its destination some point

## DIVISION I

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.

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 Commission around the entire project or any major portion of the work during construction, the Commission 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 Commission 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 responsible 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.

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### **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 Commission, 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 and temporary structures. 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 the 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.

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No special payment will be made for this work, its cost being included in the prices 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 the 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 forty-eight 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 forty-eight 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 Commission will furnish the contractor without charge two sets of plans and upon written request by the contractor additional sets of plans will be supplied without charge to a maximum of five 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

## DIVISION I

and such details as are necessary to give a comprehensive idea of the structure.

The contractor shall submit to the engineer for approval three 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 non approval 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 Commission.

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 Commission. 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, and upon completion of the work, the original corrected tracings, if so required, shall be surrendered to the Commission.

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.

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### **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 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 Commission to accept service and citation. In the performance of the work under this contract, the contractor shall so conduct his operations as to avoid interference with any other contractors.

### **5.06 Construction Stakes:**

The engineer will furnish and set construction stakes establishing lines and continuous profile grade in road work, and center line and bench mark for bridge work, and will furnish the contractor with all necessary information relating to lines and grades. This work will be performed well in advance of the contractor's requirements. The contractor shall furnish, free of charge, all additional stakes, all templates and other



## DIVISION I

materials 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 necessary to the prosecution of the work. The contractor shall be held responsible for the preservation of all stakes and marks and if, in the opinion of the engineer, any of the construction stakes or marks have been carelessly or wilfully destroyed or disturbed by the contractor, the cost of replacing them shall be deducted from any money due or becoming due the contractor.

### **5.07 Authority and Duties of Resident Engineer:**

The Resident 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 shall 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 Resident Engineer as to materials furnished or the manner of performing the work, the Resident 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 advice which the Resident Engineer may give the contractor shall in no wise be construed as binding the engineer or the Commission 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 Commission 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

## DIVISION I

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 Resident 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 advice which the inspector may give the contractor shall in no wise be construed as binding the engineer or the Commission 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 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, remove 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 by the 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

## DIVISION I

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.

All highway construction on which Federal Aid of any kind is received shall be performed under the supervision of the Commission, subject to the inspection and approval of the Federal Works Administrator or his duly accredited representative.

### **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 satisfactorily completed and the final cleaning up performed, the Resident 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.

## DIVISION I

### 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 and 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

## DIVISION I

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 standard specifications of the American Society for Testing Materials, 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 American Association of State Highway Officials, with subsequent revisions to date of contract. All tests not covered by the above shall be performed as specified by the engineer.

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### **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 and required 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.

## **SECTION 7**

### **LEGAL RELATIONS AND RESPONSIBILITIES**

#### **TO THE PUBLIC**

### **7.01 Laws to be Observed:**

The contractor is presumed to have made himself familiar with and at all times shall observe and comply with all Federal, State and Local laws and bylaws, ordinances and regulations in any manner affecting the conduct of the work, and

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shall indemnify and save harmless the Commission and its representatives against any claim or liability arising from or based on the violation of any such law, bylaw, ordinance or regulation, whether by himself or by 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 Commission. The contractor and the surety shall indemnify and save harmless the Commission 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 Commission 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:**

Any individual or corporation wishing to make an opening in the highway must secure a permit from the State Highway Engineer and the contractor shall not allow any person to make an opening unless a duly authorized permit of the engineer 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:**

Bidders are advised that pursuant to the provisions of the Federal Highway Act and acts amendatory thereof and supplemental thereto, and other Federal laws or regulations, all



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highway construction on which Federal Aid or Federal Funds of any kind is received shall be performed under the supervision of the Commission, subject to the inspection and approval of the Federal Works Administrator or his duly accredited representative. The construction work on any Federal Aid project or any project on which Federal Funds are received will be subject to inspection by the Federal Works Administrator or his agents, but such inspection will in no sense make the Federal Government a party to the 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 ten 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. 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 subgrades 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 con-

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tractor 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 condition 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 Commission.

### **7.08 Barricades, Danger, 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 acceptable 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. All barricades and obstructions shall be illuminated at night and all lights shall be kept burning from sunset until sunrise. 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

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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 Commission. 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 an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed. Any utility lines injured 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 and 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.

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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 forty-eight hours written notice, proceed to repair, rebuild, or otherwise restore such property 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 Responsibility for Damage Claims:**

The contractor shall save harmless the Commission and all of its representatives from all suits, actions, or claims of any character brought on account of any damages sustained by any person or property in consequence of any neglect in safeguarding the work, or through the use of unacceptable materials in the construction of the improvement, or on account of any act or omission by the said contractor, or by or on account of any claims or amounts recovered for any infringement of patent, trademark, or copyright, or from any claims or amounts arising or recovered under the "Workmen's Compensation Laws," 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. He 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 Commission, may be held until such aforesaid claims have been settled and suitable evidence to that effect furnished to the Commission. In case no money is due the contractor, his surety shall be held until any suit, claims or actions for injuries or damages shall have been settled.

### **7.12 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 sec-

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tion of the roadway, due to its being opened to travel under instructions from the engineer, to defective materials or work, 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 section, in a manner approved by the engineer.

### **7.13 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 non-execution 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 its completion and acceptance. 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 State Highway Engineer, the contractor will be relieved of any construction responsibility subject to the provisions of Articles 7.11, 8.10 and 9.06, Division I.

### **7.14 Personal Liability of Public Officials:**

In carrying out any of the above provisions or in exercising any power or authority granted to him by this contract, there shall be no liability upon the 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.

### **7.15 No Waiver of Legal Rights:**

Inspection by the engineer or by any of his duly authorized representatives; any order, measurement or certificate by the

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engineer; any order by the Commission for the payment of money; any payment for or acceptance of any work or any extension of time; or any possession taken by the Commission shall not operate as a waiver of any provision of the contract, or any power therein preserved to the Commission, 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 Commission 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 Commission 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.

### **7.16 Furnishing Right of Way:**

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

## **SECTION 8**

### **PROSECUTION AND PROGRESS OF WORK**

#### **8.01 Subletting or Assigning of Contract:**

The contractor shall not assign, sell, transfer or otherwise dispose of the contract, or any portion thereof, or his rights, title or interest therein, without the previous written approval of the State Highway Engineer. The contractor will not be permitted to sublet any portion of the contract, except for the delivery of materials, without the written approval of the engineer.

Roadside production of materials, unless performed by the contractor, shall be considered as subcontracting. Roadside production of materials is construed to be the production of crushed stone, gravel and/or other materials with portable or semiportable crushing, screening or washing plants established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work on a designated project or projects.

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The purchase of sand, gravel, crushed stone, crushed slag, batched concrete aggregates, ready mixed concrete and/or any other materials produced at and furnished from established and recognized commercial plants, together with the delivery of such materials to the site of the work by means of vehicles owned or operated by such plants or by recognized commercial hauling companies, shall not be considered as subcontracting under these provisions.

Except as hereinafter stated all hauling of materials from roadside production sources, or from railroad or water delivery points, to batching plants, mixing plants or directly to their place of use in the road, and all hauling of materials from batching plants and mixing plants to their place of use in the road, unless done by the contractor's own equipment or by recognized commercial hauling companies shall be considered as subcontracting under these provisions.

If batching plants or mixing plants are set up at rail or water delivery points and materials in part supplied to such plants by rail or water transportation companies, the remaining materials required at such batching or mixing plants may be hauled to such plants without such hauling being considered as subcontracting.

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 ten calendar days after the date of the work order. The contract days shall start ten calendar days after the date of the work order. The contractor shall notify the Resident Engineer at least forty-eight hours before beginning work. He shall start the work at the point designated by the engineer, shall prosecute the work at as many different points as the engineer may direct, shall complete any portion of the work in such order of time as the engineer may require, and shall provide an adequate force of labor and equipment to insure the completion of the contract within the time limit for completion as set forth in the contract. The contractor shall notify the engineer at least forty-eight hours before beginning work after suspension of work.

### **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 practic-

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able 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.

The contractor shall arrange his work and dispose of his material so as not to interfere with the operations of other contractors engaged upon adjacent work and to join his work to that of others in a proper manner, and to perform 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 or his agents to the work performed by another contractor and the Commission will not entertain any claims for damages or delays resulting from such operations.

### **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 Commission 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.

The Commission 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 utilities 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



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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 an 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.

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If the work is suspended by the engineer in the interest of the Commission 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, and he shall 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 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 ten days after the date of the work order as provided in Article 8.02, Division I, and ending with the engineer's acceptance of the work as provided in Article 8.10, Division I. The number of contract days which shall be counted for each month shall be as follows:

January—15 days	July—21 days
February—15 days	August—21 days
March—16 days	September—22 days
April—21 days	October—22 days
May—21 days	November—21 days
June—21 days	December—21 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.

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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 Commission as provided in Article 8.06, Division I.

At any time before the payment of the final estimate, the contractor may submit to the Resident 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 Resident Engineer shall promptly make a written report and recommendation on the protest or application presented by the contractor and forward it to the State Highway Engineer. The documents shall be reviewed by the State Highway 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.

### **8.08 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 Commission will be made for each and every 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 Commission on account of the expenses due to the employment of engineers, inspectors and other employees 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 sureties shall be liable for any liquidated damages in excess of amount 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,

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shall in no way operate as a waiver on the part of the Commission of any of its rights under this contract.

### 8.09 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 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 ten 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 cost 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 Commission 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

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shall pay the amount of excess to the Commission for the completion of the work.

### 8.10 Termination of Contractor's Responsibility:

The contract will be considered complete when all work has been satisfactorily completed, the final inspection made, the work accepted by the engineer, and the final estimate paid. The contractor will then be released from further obligation except as set forth in his contract bond, and except as provided in Article 7.15, 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 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 nine 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

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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 expenses incurred by, or in consequence of, the suspension or discontinuance of the said prosecution of the work as herein specified, or from any unforeseen 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 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 engineer 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 con-

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tractor, 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 and placed on the abutting property or otherwise 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

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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 Resident 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 Social Security taxes. 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 ten 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.



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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 compare 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, to the engineer 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 Resident 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 provision 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 eighty-five 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 Commission.

The amount of said estimate, after deducting fifteen 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 ren-

## DIVISION I

dered 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 Commission 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 Commission 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 Commission 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 forty-five days after the certificate of acceptance was recorded by the Commission 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.

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**DIVISION II**

**CONSTRUCTION DETAILS**

**Part 1—Earthwork**

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**SECTION 1**  
**CLEARING**

**1.01 Description:**

This item shall consist of cutting, removing, burning and cleaning up of timber, logs, brush, stumps and lapwood 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 Commission, etc., as directed by the engineer. 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 so 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. Trees that may tend to beautify and will not damage the road shall not be removed without the permission of the engineer. 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 unavoidable 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 in logs of commercial lengths and shall be piled neatly along the right of way on the downstream side, or on abutting property, if 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 fifteen 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 six inches above the ground, shall be cleared. Trees and stumps will be considered isolated when they are fifty feet or more apart.

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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 six inches above the ground.

### **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 Commission, 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 two feet or less in height, shall be removed to a depth of two feet below the finished surface of the section. In embankments of two 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 six 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.

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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 fifty 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 same degree of compaction as the surrounding subgrade.

All grubbing shall be done at least fifteen hundred feet ahead of the grading operations.

### **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, 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

## DIVISION II—PART 1

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.

### **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:**

This item 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 re-

## DIVISION II—PART 1

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 Commission, as shown on the plans or designated by the engineer, as special pits to supplement material obtained from within the highway right of way.

### 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.

### 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.



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**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 Resident 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 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 embankment, 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 roadway, 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 embankment to obtain material for curing concrete pavements, for constructing shoulders for any other purposes.

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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 engineer. 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 three 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

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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 measurement 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 the excavation under this item and placed in successive horizontal layers not exceeding eight 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 twenty 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.

Fills shall be constructed in lengths of not less than three hundred feet or for the full length of the fill if less than three hundred 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 two feet of embankment may be constructed of selected 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 eight inches loose depth, over the entire cross section by a road grader, fresno, bulldozer, or other approved equipment.

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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 two cubic feet of clean, broken stone or gravel, so placed as to allow free drainage. From approximately six 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 been in place fourteen days.

Embankments that are placed against bridge abutments, retaining walls or other structures and open end bents must be built in horizontal layers not exceeding six inches loose and for a distance, measured from the end of the structure along the center line of the road, equal to one and one-half times the height of the structure above the existing ground line and must be thoroughly compacted by hand or mechanical tamping. This method of building the embankment will extend to such height above the structure as the engineer may direct. If necessary, each layer of fill material shall be dampened to insure desired compaction and density. 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

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deposited in such other places and for such purposes as the engineer may direct.

The contractor shall be responsible for the stability of all embankments made by him, and shall replace at his expense any portions which, in the opinion of the engineer, have become displaced, due to carelessness or negligence on the part of the contractor, and not attributable to the unavoidable movement of the natural ground upon which the embankment is made.

All of the operations necessary to 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 one of the following methods or a combination of the methods as specifically provided by the special provisions.

If the specific method to be used to compact embankment is not stated in the special provisions, it is understood that the embankment must be placed in successive horizontal layers distributed uniformly over the full width of the cross section as hereinbefore set forth, and that each layer will be subjected to only such compaction as may be secured by distributing the hauling over the entire area or as may be secured by the most advantageous use of such other equipment as the contractor may be using in the construction of the embankment as the engineer may direct.

The wetting of each layer as required by the various methods of compaction set forth below may be done with a water wagon or other approved sprinkling device but the device used must be capable of delivering not less than sixty gallons per minute at the discharge end. The quantity of water required shall be sufficient to moisten the material and to secure the most desirable moisture content for proper compaction. The engineer shall be the sole judge as to the amount of water to be applied and shall determine the correct moisture content of the material by any method he may deem advisable to secure the best results. All operations relative to the compaction of embankment shall be under the direct supervision of the engineer and shall proceed in such sequence as the engineer may direct. Embankment material containing excess moisture shall be permitted to dry to the proper consistency before being compacted.

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Compaction of Embankment by use of Power Roller: Each eight inch layer shall be thoroughly rolled with a ten ton power driven roller. If the material to be used in the embankment is too dry to compact to the satisfaction of the engineer, each layer shall be wetted by sprinkling or otherwise as hereinbefore provided. If, in the opinion of the engineer, it is not practicable to use a power driven roller because the material to be used in the embankment is too wet or for other reasons the use of the roller is deemed impracticable by the engineer, and if specifically provided for in the special provisions, the contractor will be required to compact the embankment by use of a tractor or sheeps foot roller as hereinafter provided. Should, however, the special provisions not provide for the use of a tractor in connection with a power driven roller and it becomes impracticable to use a power driven roller due to the material being too wet, the contractor shall suspend work until such time as rolling with a power driven roller can be resumed. Rolling shall continue until maximum compaction has been secured.

Compaction of Embankment by use of a Caterpillar Tractor: When the special provisions provide for the use of a tractor in compacting the embankment, the contractor shall furnish and use as directed a Caterpillar tractor weighing not less than ten tons and equipped with cleated track. When a tractor is used to compact the embankment, the material used to form the embankment shall be placed in successive horizontal layers not exceeding eight inches loose depth distributed uniformly over the full width of the cross section and thoroughly compacted by use of the tractor. In compacting the embankment with the tractor, the tracks or treads shall cover the entire surface of each layer at least once. Compacting of the embankment with a tractor shall continue until maximum compaction has been secured. If the material to be used in the embankment is too dry to compact to the satisfaction of the engineer, each layer shall be wetted by sprinkling or otherwise as hereinbefore provided.

Compaction of Embankment by use of a Sheeps Foot Type Roller: When the special provisions provide for the use of a sheeps foot roller in compacting the embankment, the contractor shall furnish and use as hereinafter provided a multiple unit oscillating type sheeps foot roller and crawler type tractor. Each unit of the roller shall consist of a drum provided with tamping feet not less than seven inches long and equipped with teeth cleaning devices. The roller shall not

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weigh less than fifty pounds per linear inch of drum length without ballast and with the drums entirely filled with ballast, the roller shall weigh not less than fifty per cent more than when empty. The pressure per square inch of tamping foot area with one row of tamping feet supporting the roller shall not be less than one hundred and ten pounds without ballast. When a sheeps foot roller is used to compact the embankment, the material used to form the embankment shall be placed in successive horizontal layers not exceeding eight inches loose depth distributed uniformly over the full width of the cross section and each layer thoroughly compacted by use of the roller. The roller shall be used until maximum compaction has been secured and in every case at least six trips over the entire area of each layer will be required. If the material to be used in the embankment is too dry to compact to the satisfaction of the engineer, each layer shall be wetted by sprinkling or otherwise as hereinbefore provided.

### 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, 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 twelve inches below the surface of the subgrade and removed. Where the subgrade surface is of a compacted nature, it shall be plowed to a depth of not less than six 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 two feet below the finished surface of roadway.

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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 with a power driven roller weighing from four to ten tons or a power driven roller weighing not less than one hundred seventy pounds per inch width of tread unless otherwise specifically provided. Any portion of the subgrade that is inaccessible to the roller shall be compacted thoroughly with hand or mechanical tamps weighing not less than fifty pounds, the bearing or tamping face of which shall not exceed one hundred 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 five hundred 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 six inches below the original surface or as directed by the engineer, after which it shall be reshaped and rolled as hereinbefore specified.



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### 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 shoulder and ditch work shall not be more than four thousand 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. 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 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.

Structural Excavation for new or reconstructed structures will not be measured or paid for under this item.

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 paid for 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.

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.

Materials excavated which are used for purposes other than shown on the plans or designated by the engineer will not

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be measured or paid for. Materials excavated outside the lines and grades given by the engineer, unless specifically authorized by the engineer, shall not be measured or paid for. Slides and falls of 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.

### 4.15 Basis of Payment:

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 materials 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 prices 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 1-4-4, Borrow 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.

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### 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 structure shall not be disturbed without permission of the engineer.

Trenches or foundations 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.

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horizontal layers not over six 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 fourteen 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, if dry, shall be moistened and then compacted by tamping with mechanical rammers or by hand tamping with heavy iron tampers having a tamping face not exceeding twenty-five square inches in area.

By mechanical rammer is meant equipment designed to tamp the relatively thin layers herein prescribed. The use of drop pile hammers, loaded or unloaded clam shell 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 ten 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 two and one-half times the height thereof above low water.

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### 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, twelve 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 semi-solid material which has not been disturbed by the contractor and which cannot be drained away. 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.

#### 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, the cost of same 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 one thousand feet as required by the contract or as directed by the engineer of material paid for under "Excavation," and placed on the highway.

**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 two points such that the distance between them, measured along the center line of the highway equals one thousand 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 one hundred. 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 one thousand feet.

Where material is secured from borrow pits furnished by the Commission, 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 one thousand 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.

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### 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 section 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 two 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 far-

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thest from the roadway at such a distance from the edge of the canal as will preclude sloughing.

The embankment shall be constructed in two 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 four-fifths the width of the canal, at which point the depth shall be the maximum allowable by the conformation of the dredge. From the four-fifths 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 berm shall be as 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 fifty feet. Measurement will be made within forty-eight hours after excavation and on progress estimates, the payment will not cover yardage closer than two hundred 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



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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 Commission 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 construc-

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tion 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 five hundred 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. 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. The original marsh surface or muck mat shall not be disturbed and shall form the foundation for the hydraulic fill, unless the plans specifically provide for the excavation of a muck ditch or for dynamiting. 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 engineer deems it necessary, splash boards or dumping platforms of such size as may be required by the engineer, shall be used for the reception of materials. 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

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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. He 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.

### MEASUREMENT AND PAYMENT

#### 8.06 Method of Measurement:

Hydraulic embankment will be measured by the cubic yard and the yardage shall be determined by one of the three following methods. The particular method to be used will be designated on the plans. Quantities shall be computed by the method of average end areas.

Method "A": This method shall apply when the typical cross section on the plans indicates that payment will be made only for material remaining in place within the limits of the pay section and above the original ground lines or marsh level as hereinafter described. The yardage shall be determined as follows:

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

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the typical section and the elevations as determined by these sections will 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, as determined above, and below the upper limits of the typical cross section. No material outside of the typical section will be measured or paid for.

Method "B": This method shall apply when the typical cross section on the plans indicates that a muck ditch is to be excavated and refilled within the area to be covered by the embankment. The yardage will be measured as provided in method "A" above, and in addition, measurement will be made of the material in the muck ditch as shown on the plans or as provided below.

The quantity of material allowed for filling the muck ditch will be determined by the fixed width of the ditch indicated on the typical cross section of the plans and actual depth of muck or other unsuitable material removed therefrom. The actual depth referred to above will be construed to mean the depth below the original ground line as determined under method "A".

The quantity allowed for filling the muck ditch together with that allowed for constructing the hydraulic embankment above the original ground level, measured as provided above, will constitute the total pay quantity for hydraulic embankment. No material outside of the typical section will be measured or paid for.

Method "C": This method shall apply when the typical cross section on the plans indicates that payment will be made for the actual quantity of fill material remaining in place, within the limits of the maximum pay sections, as determined by borings made vertically through the embankment. The depth of fill will be determined by borings made vertically through the embankment at the center line and other designated points as indicated on the plans. Borings will be made at intervals of one hundred feet along the center line and at shorter intervals at bridge sites and such other places as the engineer may consider necessary to properly determine the depth of filled material. A representative of the contractor should be present when borings are being made. The decision as to whether additional borings will be made will rest with the engineer.

In determining the depth of fill material, the engineer shall endeavor to determine the line of demarcation between the fill

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material and original foundation material by an inspection of the boring. If, however, no such line of demarcation is evident, the engineer shall establish in the following manner the depth to be used. From observation of the boring, the lowest depth shall be determined where it is clearly evident that the material is filled material. The depth shall then be determined where the original material shows its natural color or texture with little or no fill material in evidence. The average of the two depths thus determined will, for the purpose of measurement, be considered the depth of fill material.

The responsibility of determining the depth of filled material shall rest upon the Resident Engineer. If any dispute should arise between the contractor and the Resident Engineer, as to the depth of the fill material at any section, the State Highway Engineer will make such additional examination of the section, as in his opinion seems necessary and shall thereby fix the depth to be allowed, which depth shall be final.

The final pay quantities for hydraulic embankment shall be the volume of fill material under the upper limits of the theoretical typical cross section, and for a depth equal to the actual depth of fill material as determined above, except that where the plans indicate maximum pay section lines, no material will be measured or paid for that finds its way outside of such maximum lines.

### **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 necessary to complete the item.

Payment will be made under:

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

## SECTION 9

### SODDING

#### 9.01 Description:

This item shall consist of furnishing, planting and maintaining approved live sod at such locations as are indicated on the plans and in accordance with these specifications.

#### 9.02 Classification:

The sodding shall be classified as follows:

Sprig Sodding

Tuft Sodding

Slab Sodding

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

Tuft Sodding shall consist of tufts of sod three inches wide and two and one-half inches thick planted to form continuous rows parallel to the highway center line. The rows of sod shall be planted twelve inches apart, center to center.

Slab Sodding shall consist of slabs of sod twelve inches wide and two and one-half inches thick planted side to side and completely covering the area to be sodded.

#### 9.03 Materials:

The sprigs, tufts or slabs of sod shall be composed of Bermuda 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 directed.

#### 9.04 Construction Methods:

After the roadway has been completed in accordance with the plans and specifications, it shall be sodded at the locations indicated on the plans or as directed by the engineer. The area 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 width indicated on the plans. Sodding shall be done at such times as the engineer shall direct and in such manner that the grass shall at once 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. Where indicated on the plans or in

## DIVISION II—PART 1

the contract, fertilizer shall be applied as specified in Article 3.04, Part 5, Division II.

### 9.05 Method of Measurement:

Measurement of sodding will be made by the station or the square yard. The particular method of measurement to be used for any specific area shall be as indicated on the plans.

Measurement by Station: Sodding will be measured by the station (one hundred linear feet), determined by measurement along the center line of the highway.

Measurement by Square Yard: 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.

Measurement of Fertilizer will be by the pound for commercial fertilizer or by the cubic yard for domestic fertilizer as specified in Article 3.06, Part 5, Division II.

### 9.06 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 the furnishing of all materials, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment for Fertilizer will be made as provided under Article 3.07, Part 5, Division II.

Payment will be made under:

- Item 1-9-1, Sprig Sodding, per station.
- Item 1-9-2, Sprig Sodding, per square yard.
- Item 1-9-3, Tuft Sodding, per station.
- Item 1-9-4, Tuft Sodding, per square yard.
- Item 1-9-5, Slab Sodding, per station.
- Item 1-9-6, Slab Sodding, per square yard.

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**DIVISION II**

**Part 2—Base Courses**

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## SECTION 1

### RECONSTRUCTED BASE COURSE

#### 1.01 Description:

This item shall consist of the reshaping of an existing surface and the addition of the required amount of new material, 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 section shown on the plans.

#### 1.02 Materials:

New materials required in the reconstruction of the base course will be indicated in the plans or in the special provisions. They shall conform to the specifications for the respective materials set forth under "Materials" in Section 2, 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 uniform 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. Guide boards shall be set accurately to line and grade at the edges of the course. 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 2.11 to 2.17, inclusive, Part 2, Division II.

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### 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 2.18, Part 2, Division II. 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 2.19, Part 2, Division II.

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

### 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 accord-

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ance 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 first class working condition, and shall have been approved by the engineer before construction begins. Rollers shall be of the three-wheeled power type weighing not less than ten tons, and shall have a rear wheel compression of not less than three hundred fifty pounds per linear inch of tire width. Other approved types of rollers may be used. Road machines shall weigh not less than three tons and shall have a wheel base not less than fifteen feet and a blade not less than ten feet.

Provision shall be made by the contractor for furnishing water at the site of the work in sufficient quantities to moisten the base material sufficiently 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, uniformly graded in size, having a per cent of wear of not more than eight (Deval abrasion test) and containing not more than five per cent of soft, friable material and not more than five per cent of flat or elongated pieces, and when tested by means of laboratory sieves shall meet the following requirements:

	Per Cent
Passing 1½ Inch Sieve.....	95 to 100
Passing No. 4 Sieve.....	0 to 15

**2.04 Washed Gravel:**

Washed or screened gravel shall consist of hard, durable particles of stone uniformly graded in size, having a per cent of wear (Deval abrasion test) of not more than fifteen and, when tested by means of laboratory sieves, shall meet the following requirements:

	Per Cent
Passing 1½ Inch Sieve.....	95 to 100
Passing No. 4 Sieve.....	0 to 15
Passing No. 4 Sieve (foreign matter).....	0 to 2

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**2.05 Washed Sand Gravel:**

Washed or screened sand gravel shall consist of clean, hard, durable particles of stone uniformly graded in size having a per cent of wear (Deval abrasion test) of not more than fifteen and, when tested by means of laboratory sieves, shall meet the following requirements:

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

**2.06 Sand Clay Gravel:**

Sand clay gravel shall be composed of either a natural or artificially prepared mixture of sand, clay and gravel. This mixture shall not contain more than five 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 requirements:

	GRADE	
	A	B
	Per Cent	Per Cent
Passing 1½ Inch Sieve.....	95 to 100	95 to 100
Passing No. 4 Sieve.....	35 to 50	50 to 70
Passing No. 10 Mesh Sieve.....	25 to 45	35 to 50
Passing No. 40 Mesh Sieve.....	15 to 35	20 to 40
Passing No. 200 Mesh Sieve.....	7 to 17	7 to 17

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 mesh sieve shall meet the following physical characteristics:

Liquid Limit (Maximum).....	25
Plastic Index .....	0 to 6

When the sand clay gravel is deficient in material retained on the No. 4 sieve, sufficient washed gravel meeting the requirements of Article 2.04 shall be added to supply the deficiency and the combined mixture shall meet the required gradation.

**2.07 Iron Ore:**

The iron ore shall consist of ferruginous sandy or gravelly material. Gravel or hard pieces of ore over two inches in larg-

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est dimension which will not be broken up during construction, or does not become compacted into the surface, shall be bladed to the shoulders of the road and disposed of as directed by the engineer. The material shall have a cementing value of at least fifty and forty to seventy per cent shall be retained on the ten mesh sieve.

**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 1/4 inch. The foreign matter content, as determined by washing, shall not exceed three 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 1/4 inch. The foreign matter content, as determined by washing, shall not exceed three per cent by weight when dry.

**2.10 Special Binder:**

Special Binder shall meet the following requirements:

	Per Cent
Passing No. 10 Mesh Sieve.....	90 to 100
Passing No. 40 Mesh Sieve.....	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 conform to the following physical characteristics:

Liquid Limit (Maximum).....	25
Plastic Index .....	0 to 6

CONSTRUCTION METHODS

**2.11 Subgrade:**

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

**2.12 Forms:**

Metal or wood forms may be used. Wood forms shall be of at least two 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.

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The forms shall not be removed until the base material is properly placed and the earth shoulders are constructed to full width and height.

### **2.13 Transporting and Spreading Base Material:**

Shell bases shall be spread and compacted in one course regardless of depth. For other types of bases where the total loose depth of material to be compacted is five inches or more, it shall be spread and compacted in two or more courses of equal depth, the maximum depth of each course being not more than five inches. The methods hereinafter specified for mixing, machining, and rolling shall apply to all courses. All base material, unless otherwise permitted by the engineer, shall be back dumped; that is, the dumping and spreading of the material shall begin at the longest haul and advance in the direction of the loading point so as not to necessitate hauling over material previously placed in the course under construction.

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. 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 one hundred foot station.

### **2.14 Mixing:**

When the base course requires binder material as provided by the plans or when the base is composed of a combination of materials, mixing of the materials will be required. The proportions of the materials incorporated and used in the base shall be as shown on the plans or in these specifications and as directed by the engineer. The several materials shall be thoroughly mixed by means of plowing, harrowing or other approved methods. This procedure 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 the mixing on each course is completed to the satisfaction of the engineer, the surface shall be shaped to conform with the typical section and compacted.

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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.

### **2.15 Compacting:**

When each course of base material has been spread, mixed and shaped as above specified, the entire surface 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 thoroughly compacted. Rolling of all but the last course shall begin at one form and continue across the roadway until the entire surface has been rolled between the forms. Before rolling the top course of the base, the earth shoulders shall be constructed to full height and cross section and the form boards removed. The rolling of the last course shall begin at one edge of the base course with the wheels overlapping the shoulders at least one-half the width of the roller and progress gradually to the center of the road overlapping each preceding track by one-half width. Rolling shall then begin at the opposite edge and proceed in like manner.

During the rolling and machining operations, the surface of the base course shall be tested with a templet cut to the required cross section and with a ten foot straight edge. All irregularities shall be corrected by scarifying to a depth of not less than four inches, 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 one-half inch from the approved cross section and grade when checked by the templet and straight edge. The templet and straight edge shall be furnished by the contractor.

### **2.16 Opening to Traffic:**

The completed base course shall be opened to traffic for a period of not less than thirty days before the wearing surface is laid, unless otherwise directed in writing by the engineer.

## DIVISION II—PART 2

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.

### **2.17 Shoulders, Ditches and Slopes:**

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

## MEASUREMENT AND PAYMENT

### **2.18 Method of Measurement:**

Measurement of base course material will be made by the cubic yard or by the ton of two thousand pounds. The particular method of measurement to be used for any specific type of base course shall be as indicated on the plans or in the contract.

**Measurement by Cubic Yard:** In the event the unit of measurement as set out in the contract is the cubic yard, measurement of all aggregate and special binder will be made in the vehicle at the point of delivery on the road as provided in Article 9.01, Division I.

**Measurement by Ton:** In the event the unit of measurement as set out in the contract is the ton, measurement of all aggregate and special binder will be made by weighing on accurate and reliable platform scales, approved by the engineer, which shall be furnished by the contractor at such points as may be designated. Such scales shall be constructed so that they are readily portable and can be transported without affecting the accuracy of the weighing device. They shall be "sealed" at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. A weigher to be appointed and compensated by the State shall weigh all materials required to be weighed as herein provided.

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

### **2.19 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 base course, which price and payment shall constitute full compensation for the furnishing of all material except roadside binder;



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for all loading, hauling, unloading, spreading, mixing, shaping, rolling, 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, per cubic yard.
- Item 2-2-2, Crushed Stone Base Course, per ton.
- Item 2-2-3, Washed Gravel Base Course, per cubic yard.
- Item 2-2-4, Washed Gravel Base Course, per ton.
- Item 2-2-5, Washed Sand Gravel Base Course, per cubic yard.
- Item 2-2-6, Washed Sand Gravel Base Course, per ton.
- Item 2-2-7, Sand Clay Gravel Base Course, per cubic yard.
- Item 2-2-8, Sand Clay Gravel Base Course, per ton.
- Item 2-2-9, Iron Ore Base Course, per cubic yard.
- Item 2-2-10, Iron Ore Base Course, per ton.
- Item 2-2-11, Clam Shell Base Course, per cubic yard.
- Item 2-2-12, Clam Shell Base Course, per ton.
- Item 2-2-13, Reef Shell Base Course, per cubic yard.
- Item 2-2-14, Reef Shell Base Course, per ton.
- Item 2-2-15, Special Binder, per cubic yard.
- Item 2-2-16, Special Binder, per ton.

### SECTION 3

#### SUBGRADE TREATMENT

##### 3.01 Description:

This item shall consist of treating the subgrade with a stabilizing course of selected material to perfect a foundation for base courses, surface courses or pavements. It shall be constructed in accordance with these specifications and in conformity with the lines, grades and typical cross sections shown on the plans.

##### 3.02 Material:

The particular type or kind of material to be used shall be designated on the plans or in the contract. Suitable material

## DIVISION II—PART 2

may be taken from the location indicated on the plans or from other approved sources.

### **3.03 Construction Methods:**

The roadbed shall be excavated to the width and depth shown on the plans. The excavated material shall be classified as "Common Excavation." After the excavation has been completed, the foundation shall be thoroughly rolled and all subgrade treatment material placed thereon and compacted as specified under Article 4.12, Part 1, Division II.

### **3.04 Method of Measurement:**

Subgrade treatment will be measured by the square yard, complete in place. The width for measurement shall be the width from outside to outside of completed subgrade treatment, 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 treated surface.

### **3.05 Basis of Payment:**

The number of square yards of subgrade treatment material placed and accepted, measured as provided above, shall be paid for at the contract unit price per square yard for "Subgrade Treatment," complete in place, which price and payment shall constitute full compensation for furnishing all material, unless otherwise specified; hauling and placing the material on the roadbed and for furnishing of all equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Excavation of the roadbed as required herein shall be paid for at the contract unit price per cubic yard for "Common Excavation."

Payment will be made under:

Item 2-3-1, Subgrade Treatment, per square yard.

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# DIVISION II

## Part 3—Surface Courses

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**SECTION 1**

**AGGREGATE TYPE SURFACE COURSES**

- 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

**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 section shown on the plans.

This item shall be constructed by either the trench method or the feather edge method. The method to be used shall be indicated 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 2.10, inclusive, Part 2, Division II, except as follows:

	Sand Clay Gravel	Special Binder
Liquid Limit (Maximum) .....	35	35
Plastic Index .....	4-10	4-10

**CONSTRUCTION METHODS**

**1.04 Subgrade:**

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

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### **1.05 Trench Method:**

The material shall be spread upon the prepared subgrade, in one or more courses, as indicated on the plans and as directed by the engineer, to such a depth that when compacted it will have the thickness shown on the plans. The material shall be spread by hand from dumping boards or by dump wagons, trucks, or equipment of a type that will distribute the material evenly over that part of the subgrade to be covered by the material. In order to secure the required thickness for any course, the contractor shall set guide boards accurately to line and grade with the inside face of these boards at the edges of the course. The boards shall be of a width equal to the required depth of the loose course, and the material shall be spread flush with the tops of the boards. After the material has been spread as above specified and the shoulders constructed, the guide boards shall be removed.

### **1.06 Feather Edge 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.

### **1.07 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 as herein provided.

### **1.08 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.

### **1.09 Shaping:**

The roadway shall be opened to traffic when directed by the engineer and while being compacted under traffic, the material

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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 accepted by the engineer.

### MEASUREMENT AND PAYMENT

#### 1.10 Method of Measurement:

Measurement of surface course material will be made by the cubic yard or by the ton of two thousand pounds. The particular method of measurement to be used for any specific type of surface course shall be as indicated on the plans or in the contract.

Measurement by Cubic Yard: In the event the unit of measurement as set out in the contract is the cubic yard, measurement of all aggregate will be made in the vehicle at the point of delivery on the road as provided in Article 9.01, Division I.

Measurement by Ton: In the event the unit of measurement as set out in the contract is the ton, measurement of all aggregate will be made by weighing on accurate and reliable platform scales, approved by the engineer, which shall be furnished by the contractor at such points as may be designated. Such scales shall be constructed so that they are readily portable and can be transported without affecting the accuracy of the weighing device. They shall be "sealed" at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. A weigher to be appointed and compensated by the State shall weigh all material required to be weighed as herein provided.

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 or ton as provided under Article 2.18, Part 2, Division II.

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### 1.11 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 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 2-2-15, per cubic yard or Item 2-2-16, per ton, as provided under Article 2.19, Part 2, Division II.

Payment will be made under:

- Item 3-1-1, Crushed Stone Surface Course, per cubic yard.
- Item 3-1-2, Crushed Stone Surface Course, per ton.
- Item 3-1-3, Washed Gravel Surface Course, per cubic yard.
- Item 3-1-4, Washed Gravel Surface Course, per ton.
- Item 3-1-5, Washed Sand Gravel Surface Course, per cubic yard.
- Item 3-1-6, Washed Sand Gravel Surface Course, per ton.
- Item 3-1-7, Sand Clay Gravel Surface Course, per cubic yard.
- Item 3-1-8, Sand Clay Gravel Surface Course, per ton.
- Item 3-1-9, Iron Ore Surface Course, per cubic yard.
- Item 3-1-10, Iron Ore Surface Course, per ton.
- Item 3-1-11, Clam Shell Surface Course, per cubic yard.
- Item 3-1-12, Clam Shell Surface Course, per ton.
- Item 3-1-13, Reef Shell Surface Course, per cubic yard.
- Item 3-1-14, Reef Shell Surface Course, per ton.

**SECTION 2**

**BITUMINOUS SURFACE TREATMENT, CLASS A**

**2.01 Description:**

This item shall consist of a wearing surface of mineral aggregate and bituminous material constructed on a prepared base, in accordance with these specifications and in conformity with the lines, grades and typical cross sections shown on the plans.

**2.02 Composition and Proportioning:**

The following three types of surface treatment are provided for in this section:

- Asphalt Cement Surface Treatment.
- Cut Back Asphalt Surface Treatment.
- Emulsified Asphalt Surface Treatment.

The kind and grade of bituminous material to be used in the construction of the wearing surface shall be indicated on the plans or in the special provisions.

Before constructing the wearing surface, one of the grades of bituminous primers shown in Table I shall be applied to the prepared base in the amount and at the temperature shown in Table I. The particular grade of primer to be used shall be as ordered by the engineer.

TABLE I

*BITUMINOUS PRIMERS*

	<i>Primer (Gal. per Sq. Yd.)</i>		<i>Temperature of Application</i>	
	<i>Min.</i>	<i>Max.</i>	<i>Min.</i>	<i>Max.</i>
Prime Application P-1.....	0.25	0.3	125°F	150°F
Prime Application P-2.....	0.25	0.3	135°F	175°F

For the wearing surface, the sequence of operations and the amounts of material per square yard of road surface treated shall be in accordance with the following Tables, Table II giving amounts per square yard of surface when Asphalt Cement is used, Table III giving amounts per square



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yard of surface when Cut Back Asphalt is used and Table IV giving amounts per square yard of surface when Emulsified Asphalt is used.

The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate shown in Tables I, II, III and IV by more than five per cent.

TABLE II

ASPHALT CEMENT

	Asphalt (Gal. at 60°F)	Coarse Aggregate (Cu. Yd.)	Fine Aggregate (Cu. Yd.)	Seal Coat Aggregate (Cu. Yd.)
First Application..... Spreading.....	0.4	.02		
Second Application..... Spreading.....	0.4		.0118	
Seal Application..... Spreading.....	0.2			.0075
Totals.....	1.0		.0375	
<i>Temperature of Application</i>			<i>Min.</i>	<i>Max.</i>
AC-1.....			275°F	350°F
AC-2.....			275°F	350°F

The quantity of bituminous material per square yard of treated surface as shown in Tables I, II, III and IV is based on a temperature of 60°F. All volumetric measurements shall be converted to this temperature in accordance with Standard Abridged Volume Correction Table for Petroleum Oils as set out in Article 2.10, Part 3, Division II.

**2.03 Equipment:**

All equipment necessary 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 suitable units, including broom dragging equipment,

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distributor and powered roller weighing not less than five nor more than seven tons. The contractor shall also provide a power revolving broom or a power blower. The broom dragging equipment, consisting essentially of nonrevolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The broom drag shall cover one-third to one-half the width of the treatment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one-lane strip. Spreading by hand as provided herein will be permitted. Aggregate

TABLE III

<i>CUT BACK ASPHALT</i>					
	<i>Asphalt (Gal. at 60°F)</i>	<i>Coarse Aggregate (Cu. Yd.)</i>	<i>Fine Aggregate (Cu. Yd.)</i>	<i>Seal Coat Aggregate (Cu. Yd.)</i>	<i>Seal Coat Sand (Cu. Yd.)</i>
First Application . . . . .	0.2				
Spreading . . . . .		.02			
Second Application . . . . .	0.4				
Spreading . . . . .			.0118		
Third Application . . . . .	0.4				
Spreading . . . . .				.0075	
Seal Application . . . . .	0.3				
Spreading . . . . .					.00375
Totals . . . . .	1.3		.04125		
<i>Temperature of Application</i>				<i>Min.</i>	<i>Max.</i>
RC-1 . . . . .				105°F	135°F
RC-2 . . . . .				125°F	155°F

spreading equipment shall have positive control, adjustable to spread accurately the given amount per square yard of road surface.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and

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appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heat and temperature at all times including thermometers reading temperature of tank contents. 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 same shall be cleaned frequently to prevent clogging of the nozzles.

TABLE IV

<i>EMULSIFIED ASPHALT</i>					
	<i>Asphalt (Gal. at 60°F)</i>	<i>Coarse Aggregate (Cu. Yd.)</i>	<i>Fine Aggregate (Cu. Yd.)</i>	<i>Seal Coat Aggregate (Cu. Yd.)</i>	<i>Seal Coat Sand (Cu. Yd.)</i>
First Application . . . . . Spreading . . . . .	0.2	.02			
Second Application . . . . . Spreading . . . . .	0.4		.0118		
Third Application . . . . . Spreading . . . . .	0.4			.0075	
Seal Application . . . . . Spreading . . . . .	0.3				.00375
Totals . . . . .	1.3		.04125		
<i>Temperature of Application</i>				<i>Min.</i>	<i>Max.</i>
EA-1 . . . . .				60°F	120°F

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to the width of the required prime coat.

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MATERIALS

2.04 Aggregate:

The aggregate shall consist of gravel, crushed stone or sand meeting the following gradation requirements:

Sieve	Per Cent Passing Square Openings			
	Coarse Aggregate	Fine Aggregate	Seal Coat Aggregate	Seal Coat Sand
1 1/2 inch.....	100			
1 inch.....	90-100			
3/4 inch.....	40-70			
5/8 inch.....		95-100		
1/2 inch.....	0-10		100	
No. 4.....		0-7	40-70	90-100
No. 10.....			0-20	
No. 20.....				50-80
No. 50.....			0-5	10-40
No. 100.....				0-5

Gravel shall consist of clean, hard, tough, durable stone fragments, free from dust, dirt, thin or elongated pieces of other objectionable matter occurring either free or as a coating on the aggregate. Gravel shall have a per cent of wear of not more than fifteen (Deval 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 six (Deval abrasion test) and a toughness of not less than six.

Sand shall consist of clean, hard, sound, durable grains, free from clay, loam or other foreign matter.

2.05 Bituminous Primers:

Bituminous primers shall conform to the following requirements:

Grade	P-1		P-2	
	Min.	Max.	Min.	Max.
Viscosity Saybolt Furol				
Sec. at 77° F.....	40	150		
Sec. at 122° F.....			100	150
Asphalt Content, per cent.....			55	65
Flash Point C.O.C. °F.....			175	

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Grade	P-1		P-2	
	Min.	Max.	Min.	Max.
<b>Distillation by Volume</b>				
Total Distillate to 437° F.....		10		5
Total Distillate to 600° F.....	25	25	18	
Total Distillate to 680° F.....		50		35
<b>Tests on Residue</b>				
Penetration at 77° F				
100 gm., 5 sec.....	70	300		
Ductility at 77° F. cm.....	60			
Float Test at 122° F. sec.....			125	
Soluble in CCl <sub>4</sub> .....	99.0		99.0	
Homogeneity Test .....	Negative		Negative	

**2.06 Asphalt Cement:**

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-1		AC-2	
	Min.	Max.	Min.	Max.
Specific Gravity 77° F.....	1.010		1.010	
Flash Point C.O.C. °F .....	347		347	
Penetration at 77° F., 100 gm., 5 sec...150	200		200	250
Loss at 325° F., 50 gm., 5 hrs., per cent	2.0			2.0
Penetration of residue at 77° F				
100 gm., 5 sec., as compared to				
original penetration per cent.....	60		60	
Bitumen (Soluble in CS <sub>2</sub> ) per cent....	99.5		99.5	
Organic matter insoluble, per cent....	0.2			0.2
Homogeneity Test .....	Negative		Negative	

**2.07 Cut Back Asphalt:**

Cut back asphalt shall be free from water, composed of a suitable petroleum distillate and asphalt base, and shall meet the following requirements:

Grade	RC-1		RC-2		RC-3	
	Min.	Max.	Min.	Max.	Min.	Max.
Flash Point (Open Tag) °F.....	80		80		80	
Furol Viscosity at 122° F.....	80	160	200	400		
Furol Viscosity at 140° F.....					275	400
<b>Distillation, per cent by volume:</b>						
Total Distillate to 374° F.....	5					
Total Distillate to 437° F.....	12		10		3	
Total Distillate to 600° F.....	25		20		14	
Total Distillate to 680° F.....	40		35		30	

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Grade	RC-1		RC-2		RC-3	
	Min.	Max.	Min.	Max.	Min.	Max.
Tests on Residue from Distillation:						
Penetration 77° F 100 g., 5 sec.	60	120	60	120	60	120
Ductility at 77° F.....	60		60		60	
Per cent Soluble in Carbon						
Tetrachloride .....	99.5		99.5		99.5	
Homogeneity Test .....	Negative		Negative		Negative	

Note: The contractor's attention is directed to the fact that Rapid Curing Cut Back Asphalts are inflammable.

**2.08 Emulsified Asphalt:**

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

Grade	EA-1	
	Min.	Max.
Viscosity Saybolt Furol, 60 ml. at 77° F., Sec.....	20	100
Residue by Distillation, per cent.....	55	60
Settlement		
5 days, per cent.....		3
†Demulsibility		
35 ml. of 0.02 N CaCl <sub>2</sub> , per cent.....	60	
Sieve Test, per cent .....	0.10	0.10

†The demulsibility test shall be made within thirty days from date of shipment.

Residue: The residue obtained from distillation shall conform to the following requirements:

Penetration at 77° F., 100 gr., 5 sec.....	100	200
Soluble in Carbon Disulphide, per cent.....	98.5	
Ash, per cent .....		2
Ductility at 77° F. cm.....	40	
Specific Gravity at 77° F.....	1.000	
Homogeneity Test .....	Negative	

**2.09 Testing:**

Testing of all bituminous materials shall be in accordance with the latest revisions of American Society for Testing Materials requirements except for Flash Point (Open Tag) and Homogeneity.

The test for Flash Point (Open Tag) shall be in accordance with method approved by Bureau of Explosives.

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The test for Homogeneity shall be in accordance with Standard Method of Test of Asphaltic Materials by Oliensis Spot, A.A.S.H.O., Method T-102.

2.10 Standard Abridged Volume Correction Table for Petroleum Oils:

This abridged table has been prepared by the U. S. Bureau of Standards and has been approved as American Standard by the American Standards Association.

The groups, coefficients of expansion, gravity (degrees A. P. I.) and gravity ranges for the several subdivisions of the present abridged table follows:

Group Number	Coefficient of Expansion at 60°F	Gravity Degrees A.P.I.	Gravity Range Group (Degrees A.P.I. at 60°F)
0	0.00035	..	Up to 14.9
1	0.00040	22	15.0 to 34.9
2	0.00050	44	35.0 to 50.9
3	0.00060	58	51.0 to 63.9
4	0.00070	72	64.0 to 78.9
5	0.00080	86	79.0 to 88.9
6	0.00085	91	89.0 to 93.9
7	0.00090	97	94.0 to 100.0

GROUP 0

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	11	1.0172	22	1.0134	33	1.0095	44	1.0056
1	1.0208	12	1.0168	23	1.0130	34	1.0092	45	1.0052
2	1.0204	13	1.0165	24	1.0126	35	1.0088	46	1.0049
3	1.0201	14	1.0161	25	1.0123	36	1.0084	47	1.0045
4	1.0197	15	1.0158	26	1.0119	37	1.0081	48	1.0042
5	1.0194	16	1.0154	27	1.0116	38	1.0077	49	1.0039
6	1.0190	17	1.0151	28	1.0112	39	1.0074	50	1.0035
7	1.0186	18	1.0147	29	1.0109	40	1.0070	51	1.0032
8	1.0183	19	1.0144	30	1.0106	41	1.0067	52	1.0028
9	1.0179	20	1.0141	31	1.0102	42	1.0063	53	1.0025
10	1.0176	21	1.0137	32	1.0098	43	1.0059	54	1.0021

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GROUP O—(Continued)

<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>
55	1.0017	97	0.9872	139	0.9728	181	0.9586	223	0.9448
56	1.0014	98	0.9869	140	0.9724	182	0.9583	224	0.9445
57	1.0010	99	0.9865	141	0.9721	183	0.9580	225	0.9441
58	1.0007	100	0.9862	142	0.9718	184	0.9576	226	0.9438
59	1.0003	101	0.9858	143	0.9714	185	0.9573	227	0.9435
60	1.0000	102	0.9855	144	0.9711	186	0.9569	228	0.9432
61	0.9997	103	0.9852	145	0.9707	187	0.9566	229	0.9428
62	0.9993	104	0.9848	146	0.9704	188	0.9563	230	0.9425
63	0.9990	105	0.9844	147	0.9701	189	0.9559	231	0.9422
64	0.9986	106	0.9841	148	0.9697	190	0.9556	232	0.9419
65	0.9982	107	0.9837	149	0.9694	191	0.9553	233	0.9415
66	0.9979	108	0.9834	150	0.9691	192	0.9549	234	0.9412
67	0.9976	109	0.9831	151	0.9687	193	0.9546	235	0.9409
68	0.9972	110	0.9827	152	0.9684	194	0.9543	236	0.9406
69	0.9969	111	0.9823	153	0.9680	195	0.9539	237	0.9402
70	0.9965	112	0.9820	154	0.9677	196	0.9536	238	0.9399
71	0.9962	113	0.9816	155	0.9674	197	0.9533	239	0.9396
72	0.9958	114	0.9813	156	0.9670	198	0.9530	240	0.9392
73	0.9955	115	0.9809	157	0.9667	199	0.9527	241	0.9389
74	0.9952	116	0.9806	158	0.9664	200	0.9523	242	0.9386
75	0.9948	117	0.9802	159	0.9660	201	0.9520	243	0.9383
76	0.9944	118	0.9799	160	0.9657	202	0.9517	244	0.9380
77	0.9941	119	0.9795	161	0.9654	203	0.9513	245	0.9376
78	0.9938	120	0.9792	162	0.9650	204	0.9510	246	0.9373
79	0.9934	121	0.9789	163	0.9647	205	0.9507	247	0.9370
80	0.9931	122	0.9785	164	0.9643	206	0.9504	248	0.9367
81	0.9927	123	0.9782	165	0.9640	207	0.9500	249	0.9364
82	0.9924	124	0.9779	166	0.9637	208	0.9497	250	0.9360
83	0.9920	125	0.9775	167	0.9633	209	0.9494	251	0.9357
84	0.9917	126	0.9772	168	0.9630	210	0.9490	252	0.9354
85	0.9914	127	0.9768	169	0.9627	211	0.9487	253	0.9351
86	0.9910	128	0.9765	170	0.9623	212	0.9484	254	0.9347
87	0.9907	129	0.9762	171	0.9620	213	0.9481	255	0.9344
88	0.9903	130	0.9758	172	0.9616	214	0.9477	256	0.9341
89	0.9900	131	0.9755	173	0.9613	215	0.9474	257	0.9338
90	0.9896	132	0.9751	174	0.9610	216	0.9471	258	0.9335
91	0.9892	133	0.9748	175	0.9606	217	0.9468	259	0.9331
92	0.9889	134	0.9745	176	0.9603	218	0.9464	260	0.9328
93	0.9886	135	0.9741	177	0.9600	219	0.9461	261	0.9325
94	0.9882	136	0.9738	178	0.9596	220	0.9458	262	0.9322
95	0.9879	137	0.9736	179	0.9593	221	0.9454	263	0.9319
96	0.9876	138	0.9731	180	0.9590	222	0.9451	264	0.9315



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GROUP O-(Continued)

<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>
265	0.9312	287	0.9242	309	0.9173	331	0.9104	353	0.9036
266	0.9309	288	0.9239	310	0.9169	332	0.9101	354	0.9033
267	0.9306	289	0.9236	311	0.9166	333	0.9098	355	0.9030
268	0.9303	290	0.9233	312	0.9163	334	0.9095	356	0.9027
269	0.9299	291	0.9229	313	0.9160	335	0.9092	357	0.9024
270	0.9296	292	0.9226	314	0.9157	336	0.9088	358	0.9021
271	0.9293	293	0.9223	315	0.9154	337	0.9085	359	0.9017
272	0.9290	294	0.9220	316	0.9151	338	0.9082	360	0.9014
273	0.9287	295	0.9217	317	0.9148	339	0.9079	361	0.9011
274	0.9283	296	0.9214	318	0.9145	340	0.9076	362	0.9008
275	0.9280	297	0.9210	319	0.9141	341	0.9073	363	0.9005
276	0.9277	298	0.9207	320	0.9138	342	0.9070	364	0.9002
277	0.9274	299	0.9204	321	0.9135	343	0.9067	365	0.8999
278	0.9271	300	0.9201	322	0.9132	344	0.9064	366	0.8996
279	0.9267	301	0.9198	323	0.9129	345	0.9061	367	0.8993
280	0.9264	302	0.9195	324	0.9126	346	0.9057	368	0.8990
281	0.9261	303	0.9191	325	0.9123	347	0.9054	369	0.8987
282	0.9258	304	0.9188	326	0.9119	348	0.9051	370	0.8984
283	0.9255	305	0.9185	327	0.9116	349	0.9048	371	0.8981
284	0.9252	306	0.9182	328	0.9113	350	0.9045	372	0.8978
285	0.9248	307	0.9179	329	0.9110	351	0.9042	373	0.8975
286	0.9245	308	0.9176	330	0.9107	352	0.9039	374	0.8972

GROUP 1

<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>
0	1.0242	14	1.0185	28	1.0128	42	1.0072	56	1.0016
1	1.0238	15	1.0181	29	1.0124	43	1.0068	57	1.0012
2	1.0234	16	1.0177	30	1.0120	44	1.0064	58	1.0008
3	1.0230	17	1.0173	31	1.0116	45	1.0060	59	1.0004
4	1.0226	18	1.0169	32	1.0112	46	1.0056	60	1.0000
5	1.0222	19	1.0165	33	1.0108	47	1.0052	61	0.9996
6	1.0218	20	1.0161	34	1.0104	48	1.0048	62	0.9992
7	1.0214	21	1.0157	35	1.0100	49	1.0044	63	0.9988
8	1.0210	22	1.0153	36	1.0096	50	1.0040	64	0.9984
9	1.0206	23	1.0148	37	1.0092	51	1.0036	65	0.9980
10	1.0202	24	1.0144	38	1.0088	52	1.0032	66	0.9976
11	1.0198	25	1.0140	39	1.0084	53	1.0028	67	0.9972
12	1.0194	26	1.0136	40	1.0080	54	1.0024	68	0.9968
13	1.0189	27	1.0132	41	1.0076	55	1.0020	69	0.9964

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GROUP 1-(Continued)

<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>	<i>t</i>	<i>M</i>
70	0.9960	106	0.9818	142	0.9678	178	0.9540	214	0.9405
71	0.9956	107	0.9814	143	0.9675	179	0.9536	215	0.9401
72	0.9952	108	0.9811	144	0.9671	180	0.9532	216	0.9397
73	0.9948	109	0.9807	145	0.9667	181	0.9528	217	0.9393
74	0.9944	110	0.9803	146	0.9663	182	0.9524	218	0.9390
75	0.9940	111	0.9799	147	0.9659	183	0.9521	219	0.9386
76	0.9936	112	0.9795	148	0.9655	184	0.9517	220	0.9382
77	0.9932	113	0.9791	149	0.9651	185	0.9513	221	0.9378
78	0.9929	114	0.9787	150	0.9647	186	0.9509	222	0.9374
79	0.9925	115	0.9783	151	0.9643	187	0.9505	223	0.9371
80	0.9921	116	0.9779	152	0.9639	188	0.9502	224	0.9367
81	0.9917	117	0.9775	153	0.9636	189	0.9498	225	0.9363
82	0.9913	118	0.9771	154	0.9632	190	0.9494	226	0.9359
83	0.9909	119	0.9767	155	0.9628	191	0.9490	227	0.9356
84	0.9905	120	0.9763	156	0.9624	192	0.9487	228	0.9352
85	0.9901	121	0.9759	157	0.9620	193	0.9483	229	0.9349
86	0.9897	122	0.9755	158	0.9616	194	0.9480	230	0.9345
87	0.9893	123	0.9752	159	0.9612	195	0.9476	231	0.9341
88	0.9889	124	0.9748	160	0.9608	196	0.9472	232	0.9337
89	0.9885	125	0.9744	161	0.9604	197	0.9468	233	0.9334
90	0.9881	126	0.9740	162	0.9601	198	0.9465	234	0.9330
91	0.9877	127	0.9736	163	0.9597	199	0.9461	235	0.9326
92	0.9873	128	0.9732	164	0.9594	200	0.9457	236	0.9322
93	0.9869	129	0.9728	165	0.9590	201	0.9453	237	0.9318
94	0.9865	130	0.9724	166	0.9586	202	0.9449	238	0.9315
95	0.9861	131	0.9720	167	0.9582	203	0.9446	239	0.9311
96	0.9857	132	0.9716	168	0.9578	204	0.9442	240	0.9307
97	0.9853	133	0.9713	169	0.9574	205	0.9438	241	0.9303
98	0.9849	134	0.9709	170	0.9570	206	0.9434	242	0.9300
99	0.9845	135	0.9705	171	0.9566	207	0.9430	243	0.9296
100	0.9841	136	0.9701	172	0.9562	208	0.9427	244	0.9293
101	0.9837	137	0.9697	173	0.9559	209	0.9423	245	0.9289
102	0.9833	138	0.9694	174	0.9555	210	0.9419	246	0.9285
103	0.9830	139	0.9690	175	0.9551	211	0.9415	247	0.9281
104	0.9826	140	0.9686	176	0.9547	212	0.9412	248	0.9278
105	0.9822	141	0.9682	177	0.9543	213	0.9408	249	0.9274

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### CONSTRUCTION METHODS

#### **2.11 Preparation of Road Surface:**

The shoulders shall have been completed for full width of roadway prior to application of priming material. The surface to be covered shall be swept clean and free from all dust, dirt, caked clay and loose foreign material by means of revolving brooms or other approved mechanical sweepers, supplemented by hand brooms. Dust or other loose material in depressions or other places not reached by mechanical sweepers, shall be swept with hand brooms. 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 surfaces of the larger size aggregate in the base are exposed.

#### **2.12 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.

#### **2.13—Application of Primer:**

The primer shall be applied to the prepared base and shall extend six 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, nor unless the surface conforms to the typical cross section shown on the plans and to the lines and grades as staked out by 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 "Application of Bituminous Material," Article 2.15, following.

#### **2.14 Patching and Repriming Prior to First Application of Bituminous Material:**

The prime coat shall be maintained intact and if required by the engineer, the primed surface shall be thoroughly clean prior to the application of the wearing surface.

Where the prime coat has failed or depressions occur, the holes shall be swept clean and brush coated with cut back asphalt and refilled with a mixture of aggregate and bituminous material and 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. The bituminous material used shall meet the requirements of cut back asphalt as specified in Article 2.07. Not less than five 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 a few days before being placed on the road.

If for any reason the engineer considers the primed base unsatisfactory for the first application of bituminous material, the contractor shall be required to reprime the unsatisfactory section.

All failures in the prime coat shall be repaired in an adequate and workmanlike manner to the satisfaction of the engineer before the wearing surface is applied.

#### **2.15—Application of Bituminous Material:**

After the prime coat has been completed and is in proper condition in the judgment of the engineer, bituminous material and cover material shall be applied in the sequence and in the amounts as shown in Article 2.02.

All bituminous materials 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 only one-half width of the roadway at one time. Special precautions shall be observed to the end that an even and uniform distribution of bituminous material shall be obtained and the distributing machine shall be so adjusted and operated as to at all times distribute evenly the material being applied. If the contractor should be unable to keep the application of bituminous material consistently within the allowed variations as set forth herein, 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 these limits.

If one or more nozzles should become blocked during the application of bituminous materials, the distributor shall be stopped immediately and the nozzle or nozzles cleaned out. When the engineer directs that application be made over one-half width of the road at one time, all of the nozzles, except the one toward the outside of the road, shall have the same size opening; and great care shall be taken to see that there is a slight longitudinal overlapping of the two applications along the center line of the road so as to insure complete

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coverage. The contractor will be required to drive the distributor 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 two applications, the distribution 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, properly 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 over 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.

Any excess of bituminous material at the transverse 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 nozzle or hand-pouring pot.

The application of the prime coat to the base shall not exceed the first application of bituminous material by more than four miles. The first application of bituminous material shall not exceed the second application by more than 1500 feet. The second application of bituminous material shall not exceed the third application by more than 1500 feet and when cut back or emulsified asphalt surface treatment is specified, the third application of bituminous material shall not exceed the fourth application by more than 1500 feet.

### **2.16 Spreading Cover Material:**

The aggregate shall be spread by casting it with shovels in a longitudinal direction from piles previously placed along the shoulders of the road or by power spreaders or trucks equipped to distribute the aggregate, provided such trucks or spreaders do not drive on the uncovered asphalt. The aggregate shall be placed in piles or spread by power spreaders or trucks in order to insure that the correct amount of aggregate per square yard will be applied. If, due to the impracticability of detouring highway traffic, the engineer may have directed that the bituminous material be applied to only one-half width of the road at a time, the aggregate shall be spread only to within eight inches of the edge of the application along the center of the road until the bituminous material shall have been applied to the remaining half of the road.

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The spreading of aggregate shall at all times follow immediately the application of bituminous material, Immediately after spreading, as many men as necessary, equipped with hand brooms shall broom off all high spots. It shall then be dragged with a broom drag.

### **2.17 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 progress toward the center, each trip overlapping the prior trip about one-half the width of the roller. The first rolling must be completed within one-half hour after the cover material has been spread. During rolling, the previously spread cover material shall be uniformly broomed in place 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. Where emulsified asphalt is specified, the coarse aggregate shall be rolled once over only. The remaining courses shall be rolled as specified above.

### **2.18 Finishing:**

The finished surface shall be uniform and shall conform to the lines, grades, and typical cross section shown on the plans, and when tested with a templet and straight edge shall show no appreciable variation. 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.

### **2.19 Protection:**

Traffic should not be allowed to use the road until the final application has been placed and thoroughly rolled.

After the prime coat has been applied, and unless it is impracticable to detour highway traffic, the contractor shall keep all traffic off of the road until, in the opinion of the engineer, the bituminous material has penetrated and dried out so as not to pick up under traffic. In cases where traffic is permitted by the engineer, the contractor shall spread the

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minimum necessary amount of approved cover material over the bituminous primer to avoid its "picking up."

During the period that brooming and rolling may be necessary, the contractor shall respread the seal coat aggregate or sand that may be whipped to the sides by traffic. This resspreading shall be done with shovels, hand brooms, or revolving broom, as 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 resspreading of the seal coat aggregate or sand is inadequate for this purpose and the engineer so directs, the contractor shall spread additional seal coat aggregate or sand as may be necessary to prevent "bleeding" and "picking up."

### MEASUREMENT AND PAYMENT

#### 2.20 Method of Measurement:

Bituminous surface treatment will be measured by the square yard, complete in place. The width for measurement shall be the width from outside to outside of completed surface treatment constructed in accordance with the plans or as directed by the engineer. The length shall be the actual center line length measured along the riding surface.

#### 2.21 Basis of Payment:

The number of square yards of bituminous surface treatment completed and accepted, measured as provided above, shall be paid for at the contract unit price per square yard for "Bituminous Surface Treatment," complete in place, which price and payment shall constitute full compensation for furnishing all materials, tools, labor, equipment, and incidentals and the performance of all work necessary to complete the item and for all royalties or payments whatsoever for patents covering processes or equipment used in connection therewith.

Payment will be made under:

- Item 3-2-1, Bituminous Surface Treatment (Asphalt Cement), per square yard.
- Item 3-2-2, Bituminous Surface Treatment (Cut Back Asphalt), per square yard.
- Item 3-2-3, Bituminous Surface Treatment (Emulsified Asphalt), per square yard.

**SECTION 3**

**BITUMINOUS ROAD MIX SURFACE COURSE, CLASS C**

**3.01 Description:**

This item shall consist of a wearing course, composed of mineral aggregate and bituminous material, mixed in place on the prepared base, constructed and sealed in accordance with these specifications and finished in conformity with the lines, grades and typical cross section shown on the plans.

**3.02 Composition and Proportioning:**

The grade of bituminous material to be used in the construction of the wearing surface shall be indicated on the plans or in the special provisions.

Before construction of the wearing surface one of the grades of bituminous primers shown in Table 1, Article 2.02, Part 3, Division II, shall be applied to the prepared base in the amount and at the temperature shown in the table. The particular grade of primer to be used shall be as ordered by the engineer.

For the wearing surface, the sequence of operations and the amounts of material per square yard of road surface treated shall be in accordance with the following table:

	<i>Asphalt (Gal. at 60°F)</i>	<i>Coarse Aggregate (Cu. Yd.)</i>	<i>Seal Aggregate (Cu. Yd.)</i>
First Spreading (Coarse Aggregate) .....		0.065	
First Application Road Mix .....	0.5		
Second Application Road Mix .....	0.5		
Seal Application .....	0.3		
Spreading (Seal Aggregate) .....			0.01
Totals .....	1.3	0.075	

<i>Temperature of Application</i>	<i>Min.</i>	<i>Max.</i>
RC-1 .....	105°F	135°F
RC-2 .....	125°F	155°F
RC-3 .....	145°F	175°F



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The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate shown in the above table by more than five per cent.

The quantity of bituminous material per square yard of surface as shown in above table is based on a temperature of 60° F. All volumetric measurements shall be converted to this temperature in accordance with Standard Abridged Volume Correction Table For Petroleum Oils as set out in Article 2.10, Part 3, Division II.

### 3.03 Equipment:

All equipment necessary 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 suitable units including tractor-drawn or motor bladers, approved distributors, powered rollers weighing not less than six nor more than eight tons, supplemented by spreading and smoothing apparatus, retread mixer, steel brush or broom drag, and other necessary finishing equipment designed and operated to avoid causing as well as to remedy corrugations and irregularities and to produce a true riding surface of uniform texture.

The heating equipment supplied shall be of adequate capacity to heat the bituminous material properly. Heating of cars, tanks and distributors shall be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited, if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

Distributors shall meet the requirements set forth under "Equipment" in Article 2.03, Part 3, Division II.

For broadcasting the cover aggregate a spreader shall be provided unless waived by the engineer. It shall be so designed, with a positive control, that the required amount of aggregate per square yard shall be deposited in a thin uniform sheet. Preferably, it shall be a hopper type spreader with a large drum in the bottom of the hopper, so arranged and driven by the supporting wheels that the speed of the oper-

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ation will not affect the regularity of the spread. The control gates shall be so arranged that the operator cannot vary the desired amount accidentally.

MATERIALS

**3.04 Aggregate:**

Aggregate shall consist of crushed gravel or crushed stone, meeting the following gradation requirements:

Sieve	Per Cent Passing Square Openings	
	Coarse Aggregate	Seal Aggregate
1½ inch.....	100	
1 inch.....	90-100	100
½ inch.....	0-15	90-100
No. 4.....	0-5	0-15
No. 8.....		0-5

Gravel shall consist of clean, hard, tough, durable stone fragments and shall be screened and crushed to size as necessary to meet the above grading requirements. At least fifty per cent of the material retained on the No. 4 sieve, as indicated by samples tested, shall have one or more fractured faces. Gravel shall have a per cent of wear of not more than fifteen (Deval 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 six (Deval abrasion test) and a toughness of not less than six.

**3.05 Bituminous Primers:**

Bituminous primers shall meet the requirements of Article 2.05, Part 3, Division II.

**3.06 Cut Back Asphalt:**

Cut back asphalt shall meet the requirements of Article 2.07, Part 3, Division II.

**3.07 Testing:**

Testing of all bituminous materials shall be in accordance with the latest revisions of American Society for Testing Materials requirements except tests for Flash Point and Homogeneity.

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The test for Flash Point shall be in accordance with method approved by Bureau of Explosives.

The test for Homogeneity shall be in accordance with Standard Method of Test of Asphaltic Materials by Oliensis Spot, A.A.S.H.O., Method T-102.

### CONSTRUCTION METHODS

#### **3.08 Preparation of Road Surface, Weather Limitations and Application of Primer:**

The preparation of road surface, weather limitations, and application of primer shall be in accordance with Articles 2.11, 2.12 and 2.13, respectively, Part 3, Division II.

#### **3.09 First Spreading of Aggregate:**

After the prime coat has been completed and is in proper condition in the judgment of the engineer, coarse aggregate in the required amount per square yard shall be spread uniformly in a windrow on the prepared base. The aggregate shall be spread only when the prepared surface is firm, intact and free from water. If rain falls on the loose aggregate, and the engineer so directs, it shall be windrowed and respread to facilitate drying. If directed by the engineer, the operations shall be confined to one-half, or one lane, of the road, leaving the remainder of the road unobstructed for public traffic.

#### **3.10 First Application of Bituminous Material:**

The moisture content of the aggregate shall not exceed two per cent. Upon the coarse aggregate, spread as required above, the bituminous material shall be applied uniformly with the prescribed pressure distributor in the required amount per square yard. The temperature of the material during application shall be within the range specified for the particular grade being used.

#### **3.11 Partial Road Mix:**

Immediately following the application, the aggregate and bituminous material shall be mixed by blading from side to side of the road or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing care shall be taken that none of the mixture is spread on earth shoulders or on any unprepared areas where it may become contaminated with earth and extraneous matter. Care shall also be taken not to dig into or disturb the underlying base course.

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After mixing, the bituminous material shall be again spread in place to receive the next increment of bituminous material.

### 3.12 Second Application and Road Mixing:

Immediately after the first mixing has been accomplished and before the bitumized material is entirely dried or set, the second application shall be made in the required amount per square yard and thoroughly road mixed as required for the first application. The mixing shall continue until all particles are coated and the mixture gets viscous and begins to set. The mixed material shall then be spread and bladed to the specified width and cross section until a true even surface is obtained.

### 3.13 Rolling:

As soon as the mixture is in proper condition of tackiness, it shall be rolled so as to cover the whole surface once, slightly overlapping each trip of the roller. Any area that tends to ravel shall be repaired with premixed material. After rolling once any irregularities in the surface shall be corrected by planing with equipment as specified herein. The planing shall continue until all irregularities are removed.

Rolling shall then be continued until the mixture is well keyed and does not move under the roller, but shall be discontinued before the aggregate is crushed or pulverized. If necessary to prevent picking up of the surface mixture by the roller, the wheels may be moistened, but an excess of either water or oil will not be permitted.

### 3.14 Testing Surface:

When a straight edge ten feet long is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than three-eighths of an inch from the lower edge of the straight edge. Irregularities shall be corrected as specified above. The surface shall be maintained in that condition of trueness by the contractor until accepted for traffic or until the completion of the contract.

### 3.15 Seal Coat:

After previous applications have cured sufficiently or when practically all the cut back agent has evaporated, the seal coat shall be applied. It is not contemplated that any fixed time be set for allowing previous applications to cure before applying the seal coat as same will vary due to weather conditions.

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Traffic, especially heavy trucks, should be kept off the road surface during this curing period.

The seal application of bituminous material shall be made in the manner hereinbefore prescribed for previous applications, and seal coat aggregate spread in the required amount per square yard, and the whole work rolled and broom dragged until the surface is tightly sealed. The road shall then be opened to traffic. The rolling shall be continued at proper periods during several days and the work shall be maintained under traffic as ordered by the engineer.

### **3.16 Application of Bituminous Material; General:**

If during any application any spots are missed, bituminous material shall be applied to those spots by some means which will insure that the spot will be bitumized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be stopped promptly when the uniform flow decreases, indicating that the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly 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 over 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. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

## MEASUREMENT AND PAYMENT

### **3.17 Method of Measurement:**

Bituminous road mix surface course will be measured by the square yard, complete in place. The width for measurement shall be the width from outside to outside of completed surface course constructed in accordance with the plans and specifications or as directed by the engineer. The length for measurement shall be the actual center line length measured along the riding surface.

**3.18 Basis of Payment:**

The number of square yards of bituminous road mix surface course completed and accepted, measured as provided above, shall be paid for at the contract unit price per square yard for "Bituminous Road Mix Surface Course," complete in place, which price and payment shall constitute full compensation for furnishing all materials, tools, labor, equipment and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 3-3-1, Bituminous Road Mix Surface Course, per square yard.

**SECTION 4**

**PORTLAND CEMENT CONCRETE PAVEMENT**

**4.01 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 section shown on the plans.

**4.02 Proportions and Consistency of Concrete:**

Type "B" Concrete Pavement shall be composed of one part of Portland cement and five parts of total fine and grade "B" gravel coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, two parts fine aggregate, and three parts of gravel coarse aggregate, by volume.

\*Type "C" Concrete Pavement shall be composed of one part of Portland cement and five and three-quarters parts of total fine and small size and large size grade "C" coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, two parts fine aggregate and three and three-quarters parts of coarse aggregate, by volume.

Type "D" Concrete Pavement shall be composed of one part of Portland cement and five and one-half parts of total fine and grade "D" gravel coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part

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cement, two parts fine aggregate and three and one-half parts of gravel coarse aggregate, by volume.

\*Type "E" Concrete Pavement shall be composed of one part Portland cement and six and six-tenths 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, two parts fine aggregate, and four and six-tenths parts of coarse aggregate, by volume.

Type "F" Concrete Pavement shall be composed of one part Portland cement, and five and one-half parts of total fine and grade "F" crushed stone coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one part cement, two parts fine aggregate and three and one-half parts of coarse aggregate, by volume.

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 State Highway Engineer, the contractor may be permitted to use a High-Early-Strength Portland cement. The additional cost involved (if any) shall be assumed by the contractor. In the event the State Highway 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 Commission 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

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\*NOTE: The contractor's attention is directed to the fact that in Type "C" and Type "E" pavements, the two coarse aggregates will reduce in volume approximately eight per cent on becoming mixed.

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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 "Testing Laboratory" in accordance with A. S. T. M. method C 29-27. 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	1.30
"D" .....	5.50	1.35
"E" .....	6.00	1.25
"F" .....	5.50	1.50

The cement content indicated above is in each case the minimum permitted, but is not guaranteed by the Commission. 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.



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The consistency of the concrete shall be such that the slump of the concrete shall be not less than one and one-half inches nor more than three inches when subjected to the following test: A frustrum of a cone having a top diameter of four inches, a base diameter of eight inches and a height of twelve inches shall be placed on its base and filled with concrete in four inch increments, each increment being rodded twenty-five times with a smooth, round, bullet pointed, steel rod, twenty-four inches long and five-eighths of an inch in diameter. The frustrum of the cone shall then be immediately removed slowly and the vertical settlement or slump of the concrete measured. (See A. S. T. M. D. 138-32T for more detailed information.)

### **4.03 Engineer's Field Laboratory:**

The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory shall be not less than ten feet wide, twelve feet long and seven feet high, floored and provided with a work bench with necessary drawers and have not less than two 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.

### **4.04 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 first class 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 first class working condition throughout the construction of the project.

## MATERIALS

### **4.05 Portland Cement:**

Portland cement shall meet the requirements of Article 5.03, Part 4, Division II.

### **4.06 High-Early-Strength Portland Cement:**

High-Early-Strength Portland cement shall meet the requirements of Article 5.04, Part 4, Division II.

### **4.07 Water:**

Water for use with cement in mortar or concrete shall meet the requirements of Article 5.05, Part 4, Division II.

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### **4.08 Fine Aggregate:**

Fine aggregate shall meet the requirements of Article 5.06, Part 4, Division II.

### **4.09 Coarse Aggregate:**

Coarse aggregate shall meet the requirements of Article 5.07, Part 4, Division II.

### **4.10 Bar Reinforcement:**

Bar reinforcement shall meet the requirements of Section 6, Part 4, Division II. Specific reference is made to Articles 6.02 and 6.03.

### **4.11 Fabric reinforcement:**

Wire for fabric reinforcement shall meet the requirements of Section 6, Part 4, Division II. Specific reference is made to Article 6.04.

### **4.12 Metal Parting Strip:**

Metal parting strips shall be shaped from metal of a gauge shown on the plans and shall be free from bends and kinks. It shall conform to the dimensions and shall be punched for pins and tie bars as shown on the plans. Sections of metal parting strips shall be so designed that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint, or other approved methods.

### **4.13 Dowel Bars:**

Dowel bars shall meet the requirements for plain bars under either Article 6.02 or 6.03, Part 4, Division II.

### **4.14 Expansion Joint Filler:**

Timber used for cypress expansion joint filler shall be preferably un-seasoned cypress, free from knots, sap-wood and all other defects, except pin worm holes not exceeding one-sixteenth inch. Cypress expansion joint timber shall be sized while dry and shall be soaked in water for a period of not less than twenty-four hours before being installed in the pavement slab. The timber shall not be allowed to dry out but shall be kept thoroughly wet until installed in the slab.

### **4.15—Poured Filler:**

(a) Asphalt Filler: The asphalt shall be homogeneous, free from water and shall not foam when heated to 175°C. (347°F.).

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It shall meet the following requirements for physical and chemical properties:

1. Specific Gravity, at 25°C. (77°F.), not less than 1.010.
2. Flash point not less than 175°C. (347°F.).
3. Penetration at 25°C. (77°F.), 100 g., 5 sec., 40 to 50.
4. Ductility at 25°C. (77°F.), not less than 30.
5. Loss at 163°C. (325°F.), 5 hours, not more than 2%.  
Penetration of residue at 25°C. (77°F.), 100 g., 5 sec., as per cent of the original penetration, not less than 50.
6. Per cent of total bitumen soluble in CCl<sub>4</sub>, not less than 99.0.

(b) Asphalt Mineral Filler: The 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 & Ball °F.....	125	145
2. Penetration at 32°F., 200 g., 1 min.....	22	
3. Penetration at 77°F., 100 g., 5 sec.....	50	65
4. Ductility at 100°F., Cm.....	20	
5. Bitumen Soluble in Carbon Disulphide, per cent	40	50
6. Mineral Filler, per cent.....	50	60
7. Water (By Distillation), per cent.....		2
8. Organic Matter, per cent (Included in Min. Filler)		4

### 4.16 Paint:

(a) Traffic Stripe Paint: Traffic stripe paint shall meet the requirements of Section 4, Part 6, Division II. Specific reference is made to Articles 4.02 (h) and 4.04 (g).

(b) Red Lead Paint: Red lead paint shall meet the requirements of Section 4, Part 6, Division II. Specific reference is made to Articles 4.02 (a), 4.03 (a), 4.04 (a), 4.05 (a) and 4.05 (b).

## CONSTRUCTION METHODS

### 4.17 Devices for and Methods of Measuring Materials:

All cement and aggregate for concrete pavements shall be measured by weight. Cement shall be measured by the bag as packed by the manufacturer, one bag of cement being assumed to be one cubic foot in volume and to weigh ninety-four pounds. The weights of course and fine aggregates to be used shall be calculated from the proportions specified by the engineer. Water shall be measured by volume or by weight.

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### 4.18 Weighing and Batching Equipment:

The batching plant shall include batcher bins, either of the stationary or mobile types, with adequate separate compartments for fine aggregate and for each required "separated size" of 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 minute quantities and shut off with precision. Means of removing the overload of any one of the several materials shall be provided. In the type where more than one aggregate is weighed into one hopper, each aggregate shall be held in a separate compartment and so arranged that an overload of any aggregate can be removed. Hoppers shall be constructed so as to eliminate accumulations of tare materials and to fully discharge without jarring the scales. 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.

The scales for weighing aggregates shall be either the horizontal beam or the springless dial types, designed of rugged construction as an integral unit of the batching plant, with a maximum allowable error of one-half per cent of net load and with significant gradation down to two pounds. Provision, such as a "tell tale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached, which device shall indicate at least the last two hundred pounds of load. A device on weighing beams shall indicate critical position clearly. Poises shall be designed for locking in any position and to prevent unauthorized removal. The weight beam and "tell tale" device shall be in full view of the operator while charging the hopper and he shall have convenient access to all controls and a clear view of all operations at the batching plant. If necessary, burlap or other suitable materials shall be arranged about the scales to afford protection against wind.

Clearance between scale parts, hoppers and bin structures shall be such as to avoid displacement of or friction between working parts due to accumulations, vibrations 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 designated

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that all exposed fulcrums, clevises and similar working parts may readily be kept clean. Scales shall be constructed of non-corrosive materials, excluding material softer than brass. Ten fifty-pound weights shall be available for checking. Weight 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. If necessary to provide stability concrete foundations for batching and weighing equipment shall be provided. All structural members of the batching plant shall be of sufficient size to withstand the load to which they will be subjected and the engineer may require the contractor to submit for approval plans showing structural design and type of foundation to be used. The contractor shall maintain the equipment in good condition and adjustment and shall provide for accurate operation. If, for any reason, equipment previously approved becomes unsatisfactory, it shall be repaired or replaced before proceeding with the work.

Water measuring equipment shall be accurate to within one per cent, and shall be so arranged that the measurement will not be affected by variations of pressure in the water supply line, or tilting of the mixer, and will be uniformly 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 volume of the auxiliary tank shall be at least equal to that of the measuring tank.

### 4.19 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 other segregation of the component sizes shall be subject to the approval of the engineer. In any case, stock piles shall be at least six feet in height and built up in layers of not more than three 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 such are required by the contract, 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

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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 twelve hours before being batched.

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.

Cement in original shipping packages may be transported on top of the aggregates, each batch containing the number of bags required by the "job mix."

Batches shall be delivered to the mixer separate and intact 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.

### 4.20 Mixing Conditions:

Concrete shall be mixed only in the quantity required for immediate use. Concrete which does not meet the requirements 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 State Highway 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 a central mixing plant will not be permitted unless specifically approved by the State Highway Engineer in writing. When such approval is given, the concrete shall be mixed to such consistency that the hauling will cause no segregation of the constituent materials. The methods of storing

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and hauling materials and equipment used shall be subject to the approval of the State Highway Engineer. Vehicles shall be equipped with suitable devices for slowly agitating the concrete during transit and for delivering of the concrete in an unsegregated condition of uniform consistency. Any vehicle load showing nonuniform consistency upon arrival will be subject to rejection.

When a central mixing plant is used, subgrade planer shall be used, complying with the requirements for the subgrader hereinafter provided under conditioning of subgrade.

### 4.21 Mixers:

Mixers, except those at central mixing plants, shall be of the boom and bucket type, full power controlled, and no mixer shall be used which requires less than five bags of cement per batch except that 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 two 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 fourteen and not more than twenty 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 one and one-half 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 4.18, Part 3, Division II.

Pickup and throw over blades in the drum of the mixer which are worn down three-quarters of an inch or more in depth must be replaced by new blades.

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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 thirty seconds.

### 4.22 Mixing Concrete:

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 twenty seconds. The rate of flow shall be so regulated that the water will enter the drum for approximately five seconds before the materials and continue to flow for approximately ten 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 and the volume of mixed concrete per batch shall not exceed the manufacturer's rated capacity by more than ten 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 three-tenths 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.

### 4.23 Forms:

Side forms shall be made of steel except that, on curves having radii of three hundred feet or less, wooden forms of



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approved thickness may be used. Metal forms shall have a minimum length of ten feet. On curves having radii less than one hundred feet, flexible or curved forms of proper radius shall be used. The forms shall be of approved section, straight, free from warp or bends and of sufficient strength when staked to resist the pressure of the concrete and finishing machine or finishing tools without springing, settlement or lateral movement. The depth of forms shall equal the depth of the concrete and the base width shall be not less than eight inches for all forms eight inches or more in height. All side forms less than eight inches in height shall have a base width of not less than six inches. The steel forms shall be not less than nine gauge (U. S. Standard Gauge 1893) except that a minimum thickness of twelve gauge will be acceptable if the section of the form is trapezoidal and thoroughly welded.

Steel forms shall meet the following minimum weights per linear foot of form exclusive of pedestals, piers, or other fastenings:

Depth of Form in inches	Minimum Net Weight per linear foot
6	8.0 lbs.
7	8.5 "
8	9.0 "
9	9.5 "

Forms varying more than one-eighth of an inch in ten feet from a true line on its upper edge or more than one-fourth of an inch from a true line on its inside face shall be rejected.

The method of connection between sections shall be such that the joint thus formed shall be free from movement in any direction and will allow no leakage.

Bent, twisted or broken forms shall be removed from the work until satisfactorily repaired and straightened. Repaired forms shall not be used until inspected and approved by the engineer. Built-up forms shall not be used.

The supply of forms shall be sufficient to permit their remaining in place not less than twelve hours after the concrete has been placed or longer if deemed necessary by the engineer.

### 4.24 Setting Side Forms:

Forms shall be set so that they rest firmly throughout their entire length upon the thoroughly compacted subgrade. Any subgrade, which at the form line is found below established grade, shall be filled to grade in lifts of one-half inch or less

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for a distance of eighteen inches on each side of the base of the form and thoroughly rerolled or tamped. Imperfections and variations above grade shall be corrected by tamping or cutting as necessary. 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 three pins for each ten 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 re-checked. Forms shall be set for at least five hundred feet in advance of the point where concrete is being placed. Forms shall be cleaned and oiled each time they are used.

### 4.25 Conditioning of Subgrade:

The subgrade shall be properly prepared, shaped, rolled and maintained in accordance with Article 4.12, Part 1, Division II. After the forms have been set and approved, the subgrade shall be tested in advance of the mixer as to crown and elevation by the use of an approved template. The subgrade template shall be so constructed that its lower or testing edge will come to the true position of the subgrade when the template is riding on the forms. Testing of the subgrade surface shall be done by moving the template back and forth on the forms without tilting or lifting. Any excess material indicated by this template shall be removed and deposited upon the adjacent shoulders, or disposed of as directed. Approved material shall be furnished and tamped or rolled in place to bring low areas up to the correct elevation. The

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subgrade shall be kept in a condition so that it will drain readily.

There shall be provided for final shaping of the subgrade an approved subgrade planer which shall ride on the forms. When the mixer is in the lane of pavement being laid, the subgrade planer shall ride on the forms and shall be attached to the discharge end of the mixer. The subgrade planer shall have a cutting edge or edges made of steel plates accurately adjustable vertically and shall be of sufficient weight to properly plane off any high spots encountered and shall have such strength and rigidity as will prevent vertical deflection. Any material planed off the subgrade shall be removed before any concrete is placed. Low places in the subgrade, as indicated by this check, shall be filled with concrete integral with the pavement, and no additional compensation shall be allowed for the extra quantity of concrete involved. The finished subgrade shall be maintained in a smooth, compacted condition until the pavement is placed.

The subgrade shall be in a moist but not muddy condition at the time of placing the concrete. If required by the engineer, it shall be saturated the previous night or not less than six 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 be such as will not form mud or pools of water.

### 4.26 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.

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

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by expansion joints constructed as hereinafter specified and of the material specified in the plans or in the special provisions.

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 ten days, or has attained a modulus of rupture of six hundred 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 one-half inch at any point and shall be tooled to the radius shown on the plans. Contact edges of slabs, except where tie rods are required, shall be painted with a heavy coat of asphalt conforming to the requirements prescribed for "poured filler" before the fresh concrete of the adjacent slab is placed against them, unless joint filler is required and used between the longitudinal slabs.

Where a center longitudinal "metal strip" joint is being constructed in the pavement, the first batch of concrete shall be discharged and distributed along such center joint and the succeeding batches alternately on each side thereof. The concrete shall be well spaded on each side of the center joint and succeeding batches shall be lapped at least twelve inches over the previous batch. Placing shall be continuous between transverse joints without the use of intermediate bulkheads.

All ends of pavement slabs not supported by dowel bars imbedded 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.

### **4.27 Placing Reinforcing Steel:**

Where required by the plans, reinforcing steel of the type and size designated on the plans shall be placed in the slab. All reinforcing metal must be clean and free from foreign materials that will prevent the proper bond with the concrete.

Fabric reinforcement shall be handled carefully and kept straight and 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 re-

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quired, 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 six inches and where laps are made at the ends of sheets, the longitudinal wires of the fabric shall be lapped not less than twelve 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.

Reinforcing 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 or during depositing and compacting of the concrete. Electric welding will be permitted provided the bars after having been welded meet the requirements of the specifications. When bars are spliced all adjacent ends shall be lapped at least forty diameters.

Strike-off boards or templates, designed to ride on the side forms and operated either mechanically or by hand, shall be used to level the concrete and secure the correct elevation for placing the reinforcing steel. Prior to the installation of the reinforcement concrete shall be deposited upon the subgrade in sufficient amount that, when leveled by a strike-off board, the surface will be at the elevation specified for the reinforcing steel. After the concrete has been struck off and leveled to the elevation specified, and before any initial set of the concrete has occurred, the reinforcing steel shall be placed thereon and covered with additional concrete in such quantity and so deposited and distributed that when finished, the pavement shall have the required thickness and crown. Sleds, chair or other devices suspending the reinforcing steel, with the consequent depositing of the concrete through the steel, will not be permitted.

### **4.28 Forming Joints:**

Expansion joints, unless otherwise provided, shall be formed with the specified joint filler and sealed with a bituminous filler meeting the requirements of the specified poured filler. The kind of joint filler to be used in expansion joints will be stated in the contract. Expansion joints of the poured type will be used when specifically provided for by the plans and special provisions. Expansion joints not less than one-half inch in width shall be formed 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 metal strip joints, except as otherwise noted on the plans. Transverse joints shall be expansion joints, dummy joints or construction 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 one-eighth inch. Concrete edges at all joints shall be tooled to the radius shown on the plans. All joints shall be trimmed and topped out 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.

#### 4.29 Longitudinal Joints:

Tie bars shall be placed across longitudinal joints if, and, as shown on the plans and shall be held in position at the spacing shown, by approved chairs or other supports at both ends. Sleds shall not be used. Tie bars shall be deformed bars and of the diameter and length shown on the plans and in no case shall the bars be painted, greased or otherwise treated to prevent bonding with the concrete. Any other approved method of tying the adjacent slabs together, shown on the plans, may be used. Tie bars shall not be used across expansion joints.

Longitudinal metal strip joints shall be formed by first installing a metal parting strip of the required gauge, shape and dimensions to be left permanently in place. The metal strip shall be securely held in place, true to line and grade, by approved steel channel pins, at intervals not greater than three feet. Adjoining sections shall be securely fastened together by lapping and pinning, or by means of slip joints or other approved methods. The contractor shall furnish an approved gauge, riding on the side forms, for accurately checking the position of the parting strip before concrete is placed against it. The parting strip shall not extend across any transverse joint.

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### 4.30 Transverse Joints:

Expansion joints shall be installed at intervals shown on the plans and in conformity therewith.

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 slab are secured. The finished joint shall be true to the line prescribed within an allowable variation of one-quarter inch in the width of one traffic lane.

The specified joint filler shall be cut to the required section and appropriately punched 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. All joint filler shall be furnished in pieces of the required width and thickness and not less than five feet in length, except where the joint for which the filler is intended is less than five feet in length, 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 three-fourths 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 ten gauge material, having flanges not less than two inches in depth. The clear width between the flanges shall be three-sixteenths inch greater than the width of the filler. The channel cap and filler shall be securely held in place with the top thereof about one-fourth inch below the proposed surface of the pavement in order to allow the finishing operations to be executed continuously.

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 side forms, the ends of the transverse expansion joints at the edges of the

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pavement shall be carefully opened for the entire depth of the slab.

Transverse dummy 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 the specified bituminous material in the manner specified under pouring 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 in the concreting operations of more than thirty minutes occurs and where the length of pavement laid from the last joint is more than ten feet. Sections less than ten feet in length between joints will not be permitted. A clean plank having a thickness of not less than three 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 the 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. A groove shall be made in the fresh concrete and the groove filled with bituminous material which shall be in every respect the same as provided for dummy joints.

### **4.31 Dowel Assembly:**

Dowels shall be prepared and placed across all transverse joints unless otherwise provided by the plans. 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. 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. The dowel bars, for their entire length, shall be painted at the site of the work with one coat of red lead paint. When the paint has dried and immediately before placing the bar in position, it shall also be coated with a thick film of heavy oil. 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



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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 must meet the approval of the engineer.

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.

In lieu of painting and greasing, the entire length of dowel bars, when so provided in the special provisions, shall be dipped in hot asphalt meeting the requirements of "Asphalt Filler."

### **4.32 Pouring Joints:**

Prior to the acceptance of the project and before the pavement is opened to traffic, all expansion joints shall be sealed and all dummy and construction joints, cracks and fractures shall be filled with the bituminous material specified for "Poured 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 poured 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 three-fourths inch below the surface of the pavement. All joints shall be clean and dry before being poured. 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.

### **4.33 Consolidating and Finishing:**

The sequence of operations shall be, first, the strike-off and consolidation, second, longitudinal floating, transverse floating

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and removal of laitance, followed by straightedging and beitting. 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.

**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 machine equipment 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 and as many times and at such intervals as required to take advantage of the conditions of the concrete, to give the proper compaction and to leave a surface of uniform texture, true to grade and contour. At least two trips will be required. Prolonged operation over a given area, however, shall be avoided. The last trip for a given area shall be a continuous run of approximately forty feet. The top of the forms shall be kept free from accumulations by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling or other variations tending to affect the precision of finish. The machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable to the correct crown or for derangement due to wear.

**Hand Methods for Strike-off and Consolidation:** When the hand method is permitted, concrete as soon as placed shall be struck off and screeded to the crown and cross section shown on the plans and to an elevation above grade so that, when consolidated and finished, the surface of the pavement shall be at the exact grade elevation indicated by 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 or tamping template shall be provided on the work. It shall be durably constructed of three or four inch lumber, steel shod, or of steel of channel cross section two feet longer than the proposed width of

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pavement slab and sufficiently strong and rigid to retain its shape under all working conditions. In making the strike-off above mentioned, the template shall be moved forward 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 templates 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 finishing 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 Commission's Standard Tool Sheets 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:** In this operation, a longitudinal float shall be worked with a sawing motion while held in floating position parallel to the road center line and passed gradually from one side of the pavement to the other. Movements ahead along the center line of the road shall be in successive advances not more than one-half the length of the float. The float may be operated from foot bridges resting on the side forms and spanning but not touching the concrete or from the sides of the pavement when provided with suitable handles.

**Transverse Floating:** After the concrete has been floated with the longitudinal float and all depressions and high spots have been removed, it shall be floated with a transverse float. A long sweeping stroke shall be used for one time over. If required, an additional transverse float may be used ahead of the longitudinal float.

**Straightedging:** While the concrete is still plastic, the slab surface shall be tested for trueness with a straightedge. The straightedge shall be held in successive positions parallel to

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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 one-half the length of the straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. Projections also shall be struck off and refinished. The straight-edge 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.

**Belting:** When most of the water sheen has disappeared and just before the concrete becomes nonplastic, the surface shall be belted. 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. Mechanically operated belts may be substituted for bow belt when approved in writing by the engineer.

**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 belting, of particles of coarse aggregate embedded near the surface. The edges of the slab shall be carefully finished with an edger of the radius required by the plans at about the time the concrete becomes hard and nonplastic and the pavement edge left smooth and true to line. Immediately after finishing is completed, channels through the shoulders or other means shall be provided to drain away surplus water.

### 4.34 Correction of Defective Surface:

After the concrete has hardened, and not later than ten o'clock of the morning following the placing of the concrete the surface of the pavement shall be again tested with a ten foot straightedge or device, which shall be operated as previously described, so as to reveal any and all irregularities. Any portion of the pavement, which shows a variation or departure from the testing edge of more than one-eighth inch and has not been satisfactorily corrected by rubbing or other approved methods, shall be removed and replaced by and at the expense of the contractor and any area or section so removed shall be not less than ten feet in length and for the full width of the section under construction.

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### 4.35 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° Fahrenheit nor resumed until an ascending air temperature in the shade and away from artificial heat reaches 35° Fahrenheit.

When concrete is being placed during cold weather and the air temperature may be expected to drop below 35° Fahrenheit, 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.

### 4.36 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, or the waterproofed paper 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.

**Wet Earth Method:** Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered with wet burlap laid directly upon the finished surface. The burlap 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 burlap shall weigh

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not less than nine 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 three feet in width and for transverse laying, the strips after full shrinkage shall be not less than two feet longer than the width of the pavement slab under construction. The manner of laying the burlap 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 must be laid to overlap six 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 shall be folded down and held in contact with the edges of the slab or the overhanging ends of the burlap 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 burlap covering shall be removed, after the expiration of twenty-four hours, the slab thoroughly wetted, and the entire surface of the pavement covered with earth not less than two 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 top or edge of slab, be left unprotected for more than one-half 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 four days dating from the time the slab is finished and the earth covering left saturated at the beginning 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 State Highway 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 seven 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.

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Ponding Method: When this method is to be used for curing, the initial curing shall be done with wet burlap as provided in these specifications under the Wet Earth Method of curing. The burlap shall be removed after the expiration of the twenty-four 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 top or edge of slab be left unprotected for more than one-half 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 four 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: When this method is to be used for curing, the initial curing shall be done with wet burlap as provided in these specifications under the Wet Earth Method of curing. The burlap shall be removed after the expiration of the twenty-four hours specified, and the entire surface of the pavement 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 four 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 engineer 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.

Unless other sizes are permitted by the engineer, each mat shall have a finished width of approximately five feet six inches and a length two feet greater than the width of the pavement

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to be cured after the mat has thoroughly shrunk. The mats shall be composed of a single layer of cotton filler completely enclosed in a cover of cotton cloth or burlap. The cotton filler shall be of low grade cotton, cotton linters, or such cotton waste as comber noils or card flat strips. The mats shall contain not less than eight ounces of cotton filler per square yard of mat, uniformly distributed. Cotton cloth or burlap used for covering shall weigh not less than seven ounces per square yard. If cotton cloth is used for covering, it shall be Osnaburg. All seams in the cover material shall be strongly stitched lapped seams. The sides of the cover shall be fastened together along both edges and the end of the mat by means of strongly stitched seams or overlocking stitching. All mats shall be stitched longitudinally with continuous parallel rows of stitching at intervals of not more than four inches, or shall be tufted both transversely and longitudinally at intervals of not more than three inches. The sewing or tufting shall not be done so tightly that the mat will not contact the surface of the pavement at all points when saturated with water. To insure the complete covering of the pavement where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be approximately six inches wide. The flap shall be strongly stitched along the edge so that it will lie flat on the pavement.

Waterproofed Paper Method: When this method is to be used for curing, the initial curing shall be done with wet burlap as provided in these specifications under the Wet Earth Method of curing. The burlap shall be removed after the expiration of the twenty-four hours specified, and the entire surface of the pavement covered with waterproofed paper. 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 eighteen 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 four 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.

Paper to be used for the curing of concrete pavement shall be of a type and quality approved by the engineer. It shall be sufficiently strong and tough to permit its use under the con-



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ditions existing on highway paving work without being torn or otherwise rendered unfit for the purpose during the curing period. 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 not less than twenty feet. Paper not manufactured in sizes which will 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. The paper shall be tested over a mortar test slab which shall be composed of one part Portland cement to 1.71 parts sand to 0.346 parts water by weight. The slab shall be cast in a non-absorbent water tight mold and shall remain in the mold throughout the test. The slab shall be approximately fifteen inches long, fifteen inches wide and two inches deep. The paper shall be applied to the exposed surface of the slab within two hours after casting. The paper shall be such that when applied to the surface of mortar slabs in the manner specified for the use of the material in the field, the mortar shall retain at least eighty per cent of the mixing water after exposure for one hundred forty-four hours to a temperature of 90°F. to 100°F. at a relative humidity of thirty per cent to fifty per cent.

**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 with wet burlap in the manner specified for the initial curing under the Wet Earth Method. The burlap shall remain in place for a period of not less than forty-eight hours, after which time the pavement may be opened to traffic in accordance with the provisions of Article 4.40, Part 3, Division II.

**Cold Weather Curing:** When the average daily temperature is below fifty degrees Fahrenheit, final curing by the above methods shall be omitted and the newly laid pavement shall be protected with not less than twelve inches of loose dry approved straw, hay, grass or other suitable blanketing material, which shall be maintained in place for ten days.

### **4.37 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

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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 contractor 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 by property holders, 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 twelve inches of earth on the pavement and covering same full length with two inch planks placed parallel to the center line of the highway. However, no earth ramp shall be constructed until the pavement is at least twenty-four 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.

### **4.38 Traffic Stripes:**

When so indicated on the typical section of the plans or required by the special provisions, traffic stripes shall be painted along the pavement at the required locations. The paint shall be applied in an approved manner so as to form traffic stripes of the required width, true to line and straight of edge.

### **4.39 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 pro-

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visions and identified on the plans as requiring 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

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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.

### **4.40 Opening to Traffic:**

Traffic shall be excluded from newly constructed pavement, constructed with Standard Portland cement, for a period of seven days after the concrete is finished (from pavement constructed with High-Early-Strength Portland cement, for a period of forty-eight 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 six hundred 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 or topped out 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.

### **4.41 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 one-eighth inch, to the thickness required by the typical cross section shown on the plans, the contract unit price shall be used in payment.

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For pavement slab, the average thickness of which, determined as hereinafter provided, is less than the thickness shown on the plans by more than one-eighth inch, but less than one-half 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 on 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 one thousand linear feet of pavement, two 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 one-eighth inch shall be considered as the specified thickness plus one-eighth inch, and measurements which are less than the specified thickness by one-half inch or more shall not be included in the average.

Payment shall be withheld for slab which is found deficient in thickness by one-half 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 one-half inch or more, determination shall be made of the actual thickness of transverse sections of the slab at twenty-five 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 one-half 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 one-half inch.

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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 two hundred 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 one-half inch tolerance in depth.

### **4.42 Finishing Shoulders:**

The construction, shaping and dressing of the shoulders shall follow the completion of the pavement as closely as practicable.

## MEASUREMENT AND PAYMENT

### **4.43 Method of Measurement:**

Portland cement concrete pavement 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, mud pump connections will be measured, complete in place, and each completed and accepted connection shall be counted.

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Metal parting strip installed and left in place will be measured by the linear foot over the joint and along the surface of the pavement.

Expansion joint filler will be measured by the square foot. The net area of expansion joint filler installed in the pavement as required by the plans, will be measured. (The area of holes punched for dowel bars will not be deducted).

Poured filler placed and for which payment is to be made on a unit price basis will be measured by the ton of 2000 pounds, invoice weights to govern.

Dowel assembly installed and left in place will be measured by the linear foot. Measurement will be made of the length of joint dowelled, by measuring along the joint. Measurement will be made horizontally and not upon the surface of the pavement.

Reinforcing steel will be measured as provided in Paragraph (b), Article 6.08, Part 4, Division II.

### 4.44 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 the shoulders, and for furnishing all materials, unless otherwise specified; the furnishing of all forms, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Provided, that payment shall be withheld for slab which is found deficient in thickness by one-half 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 less than one-half 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 hereinfore stated.

Payment will be made under:

Item 3-4-1, Portland Cement Concrete Pavement, Type "B",  
per square yard.

Item 3-4-2, Portland Cement Concrete Pavement, Type "C",  
per square yard.

Item 3-4-3, Portland Cement Concrete Pavement, Type "D",  
per square yard.

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Item 3-4-4, Portland Cement Concrete Pavement, Type "E",  
per square yard.

Item 3-4-5, Portland Cement Concrete Pavement, Type "F",  
per square yard.

Mud pump connections installed and accepted, measured as provided above, shall be paid for at the contract unit price each for "Mud Pump Connections," complete in place, which price and payment shall constitute full compensation for furnishing all materials, except poured filler, the furnishing of all tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 3-4-6, Mud Pump Connections, per each.

Metal parting strip installed and accepted, measured as provided above, shall be paid for at the contract unit price for linear foot for "Metal Parting Strip," complete in place, which price and payment shall constitute full compensation for furnishing and installing the metal parting strip and tie bars together with all necessary pins for holding the metal parting strip and tie bars in place and shall also include the furnishing of all materials, tools, equipment, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 3-4-7, Metal Parting Strip, "V" Type, per linear foot.

Item 3-4-8, Metal Parting Strip, Trapezoidal Type, per linear foot.

Expansion joint filler installed in joints in or between pavement slabs or between pavement slabs and adjoining structures, measured as provided above and accepted, shall be paid for at the contract unit price per square foot for "Expansion Joint Filler," complete in place, which price and payment shall constitute full compensation for furnishing and installing the expansion joint filler; 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 3-4-9, Expansion Joint Filler, (one-half inch thick),  
per square foot.

Item 3-4-10, Expansion Joint Filler, (three-fourths inch  
thick), per square foot.

Item 3-4-11, Expansion Joint Filler, (one inch thick), per  
square foot.



### DIVISION II—PART 3

Poured filler placed and accepted, measured as provided above, shall be paid for at the contract unit price per ton for "Poured Filler," 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.

Payment will be made under:

Item 3-4-12, Poured Filler, Asphalt, per ton.

Item 3-4-13, Poured Filler, Asphalt Mineral, per ton.

Dowel assembly installed in the pavement and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot for "Dowel Assembly," 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. If the dowels are dipped in hot asphalt in lieu of painting and greasing, no direct payment will be made for the bituminous material used but the cost of same shall be included in the unit price for "Dowel Assembly."

Payment will be made under:

Item 3-4-14, Dowel Assembly, per linear foot.

Reinforcing Steel installed in the pavement and accepted, measured as provided above, shall be paid for in accordance with Article 6.09, Part 4, Division II.

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# **DIVISION II**

## **Part 4—Structures**

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## 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," "Concrete," "Bearing Piles" 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 by the engineer before concreting operations will be permitted to begin. All equipment shall meet the specific requirements set forth under "Concrete," "Reinforcing Steel" and "Bearing Piles."

### 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."

#### 1.05 Foundations:

All foundations shall be prepared as specified under "Structural Excavation," 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 "Depositing Concrete Under Water" or unless otherwise permitted in writing by the en-

## DIVISION II—PART 4

gineer. Cofferdams and concrete seals shall be furnished and prepared as prescribed under "Structural Excavation."

### 1.06 Pile Heads:

The tops of timber piles shall project not less than twelve 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 construction. 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 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."

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."

**1.10 Placing Superstructures:**

No superstructure load shall be placed upon finished piers or abutments until the engineer directs. In general, a minimum time of 14 days shall be allowed for the hardening of concrete before any superstructure load is placed thereon.

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 three 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 two 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 1 foot center to center. The blocks shall be beveled and oiled in such manner

## DIVISION II—PART 4

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 dovetailed joint. In concrete floors not supported by longitudinal joists, any necessary construction joints 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 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.

### **1.13 Roadway Crown, Concrete and Steel Bridges:**

The crown of 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 one-half inch in depth, at a point not more than six inches from the outside face, for the purpose of arresting the flow of moisture and thus preventing staining.

### **1.14 Roadway Finish, Concrete and Steel Bridges:**

The finishing of roadway shall be performed as prescribed under "Concrete."

### **1.15 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."

#### **1.16 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 shall be composed of material not less than  $1\frac{1}{4}$  inches in thickness after being dressed and 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. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least 14 days, unless otherwise permitted by the engineer.

#### **1.17 Concrete Railings and Parapets:**

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 class "A" concrete.

**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." 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. 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.

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### 1.18—Precast Rails:

Precast railing members shall be cast in mortar tight forms. The precast members shall be removed from the moulds as soon as the concrete has set sufficiently to permit and shall then be kept covered with saturated burlap or tarpaulin for at least three days. After this, the curing shall be completed by immersion in water or by spraying not less than twice a day, for a period of not less than seven days.

The method of storage and handling shall be such as to preserve true and even edges and corners, and any precast members which become chipped, marred or cracked before or during the process of placing shall be rejected and removed from the work.

In the construction of cast-in-place railing caps and copings built in connection with precast balusters, the balusters shall be protected from staining and disfigurement during the process of placing and finishing the concrete.

### 1.19 Expansion Joints:

Expansion joints shall comply with the specifications for "Expansion Joints" under "Concrete."

## MEASUREMENT AND PAYMENT

### 1.20 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.

### 1.21 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," "Structural Steel," "Concrete," and other specifications or contract items which are to contribute to and constitute the complete structure in each case.

**MATERIALS****2.02 General:**

*See Remarks*

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."

**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." No compensation for fabrication or erection of steel superstructure or structural steel shall be allowed save as provided under "Structural Steel" hereinafter.

**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.

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### 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 one-half 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 three-fourths of the holes so filled. The steel structures shall be entirely riveted and swung before any concrete in the deck is poured.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and the cylindrical erection pins shall be 1/32 inch larger.

Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the engineer. Riv-

## DIVISION II—PART 4

ets larger than  $\frac{7}{8}$  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.

In bolted connections, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool. Pilot and driving nuts shall be used in driving pins. Nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

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." *See addition 5/50*

### 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. The bridge seat bearing area shall be swabbed thoroughly with red lead paint and then covered with three layers of 12 to 14 ounce duck, each layer being swabbed thoroughly on the surface with red lead paint. The superstructure shoes or pedestals shall be placed in position while the paint is plastic.

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.

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### 2.08 Floors:

(a) Concrete Floors: Concrete floors shall comply with the requirements for this work under "Concrete Bridges."

(b) Plank and Laminated Floors: Plank and laminated timber floors shall comply with the specifications under "Untreated and Treated Timber."

## 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 price 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," Bearing Piles" and other specifications and contract items, which are to contribute to and constitute the intended complete structure.

## MATERIALS

**3.02 Timber and Lumber:**

All timber and lumber to be used in timber bridges and fenders shall be Southern Yellow Pine surfaced four sides (S4S) unless otherwise indicated on the plans. It shall meet all of the requirements for materials under "Untreated and Treated Timber."

**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 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." All castings shall conform to the requirements therefor prescribed under "Structural Steel."

## CONSTRUCTION METHODS

**3.05 General:**

In addition to the requirements under construction methods of "Untreated and Treated Timber," 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."

**3.07 Framing:**

All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even

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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 File Bents:

The piles shall be driven as accurately as possible in the correct location and vertical or to the batter indicated on the plans. In case a pile is driven out of line, it shall be straightened without injury before it is cut off or braced. Piles damaged in driving or straightening, or piles driven below grade, shall be removed and replaced at the contractor's expense. 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 insure perfect bearing between the cap and piles of a bent.

Pile heads shall be treated in accordance with the specifications under "Bearing Piles."

### 3.09 Framed Bents:

Mudsills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than  $\frac{3}{4}$  inch diameter and projecting at least 6 inches above the tops of the pedestals shall be set in them when they are cast, for anchoring the sills or posts.

Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift bolted to mud sills or piles with bolts of not less than  $\frac{3}{4}$  inch diameter and extending into the mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than  $\frac{3}{4}$  inch diameter, extending at least 6 inches into the posts.

### 3.10 Caps for all Bents:

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to

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secure an even alignment of their ends. All caps shall be secured by drift bolts of not less than  $\frac{3}{4}$  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.

### 3.11 Bracing:

The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than  $\frac{3}{4}$  inch diameter. Intermediate intersections shall be bolted, as indicated on the plans.

### 3.12 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  $\frac{1}{2}$  inch for the circulation of air and shall be securely fastened by driftbolting where specified. When stringers are two 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 two nails at each end.

### 3.13 Floors:

Flooring on the roadway and sidewalk shall be of the type and dimensions shown on the plans.

### 3.14 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.

### 3.15 Railings:

Railings shall be built as shown on the plans. All rails shall be squarely butt-jointed at the posts and the rails shall break joints.

Rails and posts shall be untreated, and shall be painted three coats of white lead paint as stipulated in "Painting."

### 3.16 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 machine bolts shall be bored with a bit of the same diameter as the bolt.

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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.

### 3.17 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.

### 3.18 Bolts and Washers:

A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood. A standard circular washer 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

### 3.19 Method of Measurement:

The quantities of timber and of the various other contract pay items which constitute the completed and accepted 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 of this item will be made.

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.

### 3.20 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, erecting and painting all lumber, timber and other materials, 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" 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 materials and the composition and proportions for the concrete used in this item shall meet all the requirements specified under "Concrete" 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."

#### 4.04 Backfilling:

Backfilling for all retaining walls shall be as prescribed under "Structural Excavation."

Backfilling for pipe headwalls and culverts shall be as prescribed under "Excavation and Embankment."

#### 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 de-

## DIVISION II—PART 4

terminated 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."

### 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." In addition, the following requirements for the placing of concrete in culverts shall be as follows:

In general, the base slab or footings of box culverts and 6 inches of the sidewalls 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 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 side walls 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 contract 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. 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 High-Early-Strength cement will not be permitted without the written consent of the engineer.

**5.02 Equipment:**

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

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capacity of less than a one-bag batch, except in the construction of pipe headwalls where a three and one-half 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 yards capacity .....	100 Cu. Yds.

Under special conditions, and with satisfactory proof, the rating of mixers, as stated above, may be increased.

Blades: Pick-up and throw-over blades in the drum of the mixer which are worn down ¼ 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.

## MATERIALS

### 5.03 Portland Cement:

(a) Chemical Limits: The following maximum limits shall not be exceeded by amounts greater than the respective tolerances indicated as allowable in the chemical determinations:

	Limits	Tolerances
Loss on ignition, per cent.....	4.00	0.25
Insoluble residue, per cent .....	0.85	0.15
Sulfuric anhydride (SO <sub>3</sub> ), per cent..	2.00	0.10
Magnesia (MgO), per cent.....	5.00	0.40

Portland cement is the product obtained by pulverizing clinker consisting essentially of calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulfate except that additions not to exceed 1 per cent of other materials may be added, provided such materials have been shown not to be harmful by tests prescribed and carried out by Committee C-1 on Cement.

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(b) Soundness: A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking, or disintegration in the steam test for soundness.

(c) Time of Setting: The cement shall not develop initial set in less than 45 min. when the Vicat needle is used or in less than 60 min. when the Gillmore needle is used. Final set shall be attained within 10 hr.

(d) Tensile Strength:

(1) The average tensile strength in pounds per square inch of not less than three standard mortar briquets (see Section i) composed of one part of cement and three parts of standard sand, by weight, shall be equal to or higher than the following:

Age at Test, Days	Storage of Specimens	Tensile Strength PSI
7	1 day in moist air, 6 days in water.	275
28	1 day in moist air, 27 days in water.	350

(2) The average tensile strength of standard mortar at 28 days shall be higher than the strength at 7 days.

(e) Packaging and Marking: When, as specified, the cement is delivered in packages the name and brand of the manufacturer of the cement and the nature and amount of the material (found not to be harmful by Committee C-1 on Cement, Cement Reference Laboratory, National Bureau of Standards, Washington, D. C.) added to the clinker other than water and/or untreated calcium sulfate shall be plainly marked thereon. No shipment of cement in bulk will be permitted. A bag shall contain 94 lbs. net. A barrel shall contain 376 lbs. net. All packages shall be in good condition at the time of inspection.

(f) Storage: The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

(g) Inspection: Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the purchaser. At least 12 days from the time of sampling shall be allowed for completion of the 7-day test, and at least 33 days shall be allowed for completion of the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test need not be made if waived by the purchaser.

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(h) Rejection:

(1) The cement may be rejected if it fails to meet any of the requirements of these specifications.

(2) Cement remaining in storage prior to shipment for a period greater than 6 months after completion of the tests shall be retested and shall be rejected if it fails to meet any of the requirements of these specifications.

(3) Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter. The provisional acceptance of the cement at the mill shall not deprive the purchaser of the right of rejection on a retest of soundness and time of setting at the time of delivery of cement to the purchaser.

(4) Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

(i) Methods of Testing: The cement shall be sampled and tested in accordance with the Standard Methods of Sampling and Testing Portland Cement (A. S. T. M. Designation: C 77) of the American Society for Testing Materials.

**5.04 High-Early-Strength Portland Cement:**

(a) Chemical Limits: The following maximum limits shall not be exceeded by amounts greater than the respective tolerances indicated as allowable in the chemical determinations:

	Limits	Tolerances
Loss on ignition, per cent.....	4.00	0.25
Insoluble residue, per cent.....	0.85	0.15
Sulfuric anhydride (SO <sub>3</sub> ), per cent...	2.50	0.10
Magnesia (MgO), per cent.....	5.00	0.40

Portland cement is the product obtained by pulverizing clinker consisting essentially of calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulfate except that additions not to exceed 1 per cent of other materials may be added, provided such materials have been shown not to be harmful by tests prescribed and carried out by Committee C-1 on Cement.

(b) Soundness: A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking, or disintegration in the steam test for soundness.

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(c) Time of Setting: The cement shall not develop initial set in less than 45 min. when the Vicat needle is used or in less than 60 min. when the Gillmore needle is used. Final set shall be attained within 10 hr.

(d) Strength:

(1) The average strength in pounds per square inch of not less than three standard specimens shall be equal to or higher than the following:

Age at Test Days	Storage of Specimens	Option No. 1	Option No. 2
		Tensile Strength PSI	Compressive Strength PSI
1	1 day in moist air.....	275	1300
3	1 day in moist air, 2 days in water .....	375	3000

(2) If, at the option of the purchaser, a 28-day test (with storage of 1 day in moist air and 27 days in water) is required, the average strength at 28 days shall be higher than the strength at 3 days.

(3) When either of the optional strength tests is not specified by the purchaser, the tensile strength test shall be used.

(e) Packaging and Marking: When, as specified, the cement is delivered in packages the name and brand of the manufacturer of the cement and the nature and amount of the material (found not to be harmful by Committee C-1 on Cement, Cement Reference Laboratory, National Bureau of Standards, Washington, D. C.) added to the clinker other than water and/or untreated calcium sulfate shall be plainly marked thereon. No shipment of cement in bulk will be permitted. A bag shall contain 94 lbs. net. A barrel shall contain 376 lbs. net. All packages shall be in good condition at the time of inspection.

(f) Storage: The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

(g) Inspection: Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the purchaser. At least 6 days from the time of sampling shall be allowed for completion of the 1-day test, at least 8 days shall be allowed for completion of the 3-day test, and at least 33 days shall be al-

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lowed for the completion of the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test need not be made unless specified by the purchaser.

(h) Rejection:

(1) The cement may be rejected if it fails to meet any of the requirements of these specifications.

(2) Cement remaining in storage prior to shipment for a period greater than 6 months after completion of the tests shall be retested and shall be rejected if it fails to meet any of the requirements of these specifications.

(3) Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter. The provisional acceptance of the cement at the mill shall not deprive the purchaser of the right of rejection on a retest of soundness and time of setting at the time of delivery of cement to the purchaser.

(4) Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

(i) Methods of Testing: The cement shall be sampled and tested in accordance with the Standard Methods of Sampling and Testing Portland Cement (A. S. T. M. Designation: C 77) of the American Society for Testing Materials, with the following exception:

Compressive Strength: Compressive strength, when specified (Section d, Option 2), shall be determined in accordance with the Tentative Method of Test for Compressive Strength of Portland Cement Mortars (A. S. T. M. Designation: C 109) of the American Society for Testing Materials.

**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%



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Water, when used in standard soundness, time of setting, and 1-3 mortar-strength test as outlined in Standard Method T-26 A.A.S.H.O. 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 .....	.25
Clay lumps .....	.5

Fine aggregate subjected to the colormetric test for organic impurities and producing a color darker than plate three (3), Standard Method T-21 A.A.S.H.O., shall be rejected.

Fine aggregate shall be uniformly graded from coarse to fine and conforming to the following grading requirements:

Passing 3/8 In. Sieve.....	100 per cent
Passing No. 4 Sieve.....	95-100 per cent
Passing No. 16 Sieve .....	65-90 per cent
Passing No. 50 Sieve .....	7-30 per cent
Passing No. 100 Sieve not more than.....	7 per cent

**Sand for Mortar:**

Passing No. 8 Sieve.....	100 per cent
Passing No. 50 Sieve .....	15-40 per cent
Passing No. 100 Sieve .....	0-10 per cent

Strength: Fine aggregate when subjected to the mortar strength test, Standard Method T-35 A.A.S.H.O., shall show a strength 95 per cent 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.

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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 Louisiana Highway Commission 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 Commission and forwarded to the laboratory for test purposes. Check test 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.

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 have a per cent of wear (Deval abrasion test) of not more than 15. 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
Max. retained $\frac{3}{4}$ in.—0.5%	
Max. passing $\frac{3}{4}$ in.—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.	

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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 have a per cent of wear (Deval abrasion test) of not more than 8. 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 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, Square Opening in Inches**

Grade	2¾	2½	2	1½	1	¾	½	No. 4
A				100	90-100	40-85		0-5
B			100	85-100		40-85		0-5
C	See Grading Requirements Following							0-5
D		100	90-100		40-80			0-5
E	See Grading Requirements Following							0-5
F	100	90-100		40-70		0-25		0-5

For grade "C" or 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 two 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 "C"	Grade "E"
Passing 2¾	Passing 2½ .....100 per cent
2¾ to 1	2½ to 1½ .....25 to 40 per cent
1 to ½	1½ to ¾ .....20 to 45 per cent
½ to No. 4	¾ to No. 4.....20 to 35 per cent
Passing No. 4	Passing No. 4..Not more than 5 per cent

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Without written permission from the engineer, the individual sizes of coarse aggregate will be restricted as follows: The smaller size coarse aggregate for Grade "C" shall not have more than 10 per cent retained on the  $\frac{3}{4}$  inch sieve. 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  $\frac{3}{4}$  inch and not more than 8 per cent passing No. 4. The larger size coarse aggregate for Grade "C" shall not have more than 20 per cent passing the  $\frac{3}{4}$  inch sieve. The larger size coarse aggregate for Grade "E" shall have 45 to 60 per cent retained on the  $1\frac{1}{2}$  inch sieve and shall not have more than 20 per cent passing the 1 inch sieve.

### 5.08 Premoulded Bituminous Joint Filler:

The joint filler shall be an asphaltic or tar composition which will not become so soft that it will warp in warm weather, or become hard and brittle in cold weather, and shall be of such stability at all times as to make a full straight joint. Thin strips of non-metallic stiffener will be allowed, provided that the joint, exclusive of such stiffener, has the thickness shown on the plans. The filler may be impregnated with finely divided particles of non-metallic material provided that they are uniformly distributed throughout the bitumen. When tested, the Absorption shall not exceed five per cent; the Distortion shall not exceed one inch and when tested for Brittleness, the filler shall not crack or shatter.

## CONSTRUCTION METHODS

### 5.09 Classification:

Concrete shall be classified as Class "A," Class "D" 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 concrete, as required by the plans.

Class "S" concrete shall be used for all concrete deposited under water.

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**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:

- Class "A" Concrete 1:5
- Class "D" Concrete 1:6
- 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 .....	6.0
Class "D" Concrete .....	5.0
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 Commission since the cement content obtaining for 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 "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 "S" Concrete—Grade A

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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 coarse and fine aggregate shall be handled and measured separately. No batch shall be run requiring fractional bags of cement.

Cement shall be measured by the bag as packed by the manufacturer.

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 2 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  $\frac{1}{2}$  of 1 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

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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:

(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 bags of cement containing lumps or crusts of hardened material shall not be used.

Concrete shall be mixed for a period of not less than one and one-half minutes after all materials, including water, are in the drum.

During such period, the drum shall be operated at drum speeds specified by the mixer manufacturer and shown on his nameplate on the machine. 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.

(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 six 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  $\frac{1}{2}$  cubic yards in volume. Hand mixing will not be permitted for concrete to be placed under water.

### 5.14 Consistency:

The composition of the combined mixture shall be such as to produce concrete of maximum density consistent with

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workability, containing no free water, with the specified cement content, and not more than the volume of water specified in the table above.

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 using A.S.T.M. Method, Designation D 138-32T.

Class "A" Concrete 2—4 inches slump

Class "D" Concrete 2—4 inches slump

Class "S" Concrete 4—8 inches slump

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.

**5.15 Concrete Strength Requirements:**

When required by the engineer, samples of concrete for compression tests as prescribed in the A. S. T. M. Designation C 31-33, 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 "S" Concrete .....	2,000	3,000

**5.16 Falsework:**

Falsework for supporting concrete work shall be built on foundations of sufficient strength to carry the loads without appreciable settlement. Falsework which cannot be founded upon solid footings must be supported by ample falsework piling. Falsework shall be designed to carry full loads coming upon it. 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 constructing 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.



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### 5.17 Forms:

Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Forms for exposed surface shall be made of sized and dressed tongue and groove or shiplap lumber or metal in which all bolt and rivet holes are countersunk so that in either case a plane smooth surface of the desired contour is obtained. Rough lumber may be used for backing or for surfaces which will not be exposed in the finished structure. All lumber shall be free from knot holes, loose knots, cracks, splits, warps, or other defects affecting the strength or appearance of the finished structure. Form lumber shall be free from bulge or warp, and shall be cleaned thoroughly if used a second time.

In designing forms and centering, the concrete shall be treated as a liquid weighing 150 pounds per cubic foot for vertical loads, and not less than 85 pounds per cubic foot for horizontal pressure. The unsupported length of wooden columns and compression members shall not exceed 30 times the diameter of the least side.

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.

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.

The forms shall be built to line and braced in a substantial and unyielding manner. Wires for tying forms shall not extend through faces of concrete that will be exposed in the finished work. In general, forms shall be tied together with bolts that can be removed. The forms shall be mortar tight and, if necessary to close cracks due to shrinkage, shall be soaked thoroughly with water. Forms for reentrant angles shall be chamfered and for edges shall be filleted. The interior surfaces of forms shall be adequately oiled, greased, or soaped to insure nonadhesion of mortar. Forms shall be inspected by the engineer immediately prior to placing concrete. Dimensions shall be checked carefully and any bulging or warping shall be remedied and all dirt, sawdust, shavings, or other debris within the forms shall be removed. Special attention shall be paid to ties and bracing, and where forms appear to be insufficiently

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braced or unsatisfactorily built, either before or during construction, the engineer shall order the work stopped until the defects have been corrected to his satisfaction. Forms shall be so constructed that the finished concrete shall be of the form and dimension shown on the plans, and true to line and grade. Cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

### 5.18 Placing Concrete:

Concrete shall be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach final position in the forms within 30 minutes after water is first added to the mix. The method of placing shall be such as to avoid segregation of the aggregates or displacement of reinforcement.

Use of long chutes for conveying concrete from mixing plant to forms will not be permitted. Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. 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.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

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,

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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.

Unless otherwise directed by the engineer, the concrete after having been placed in the forms shall be thoroughly compacted by means of an approved internal vibrator. The vibrator shall be placed directly in the forms and preferably shall not be operated while it is in contact either with the inside or the outside of the forms or to the reinforcing steel in any manner. The compaction shall be produced by inserting the machine in the concrete directly for a period of approximately twenty to thirty seconds. This insertion shall occur approximately every two and one-half feet, or where necessary to produce concrete of maximum density. Continuous attention shall be given to the working of concrete next to forms and around reinforcing steel, and embedded fixtures or inserts. The contractor shall furnish and use as a minimum, one vibrator for every 25 cubic yards of concrete placed per hour and shall keep spare units in reserve.

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 beneath. 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."

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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 provided 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.

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" 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, 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 water tight. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

The tremie used shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flange 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. The

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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 be interrupted until the work is completed.

### 5.20 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 other 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.

### 5.21 Forming Joints:

(a) Construction Joints: When the work of placing concrete is delayed until the concrete has taken initial set, the

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point of stopping shall be deemed a construction joint. 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 be located at points of minimum shear.

At all horizontal construction joints and at other locations, when directed, a gage 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. Rough stone or 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 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 two layers of three-ply roofing felt to separate the concrete.

(d) Expansion Joints: Expansion joints shall be used where shown on the plans. The thickness of the expansion joint shall be as required on the plans. Premoulded bituminous joint filler,

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when required, shall be cut to the same shape as the area to be covered but  $\frac{1}{4}$  inch smaller along all surfaces that will be exposed in the finished work. It shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when the concrete is deposited against it. Where necessary to use more than one piece to cover any surface, the abutting pieces shall be placed in close contact and the joint between the separate pieces shall be covered with a layer of two-ply roofing felt, one side of which shall be covered with hot asphalt to insure proper retention. The  $\frac{1}{4}$ -inch space along the edges at exposed faces shall be filled with wooden strips of the same thickness as the joint material. These wooden strips shall be saturated with oil and have sufficient "draft" to make them readily removable after the concrete is placed. Immediately after the forms are removed the expansion joints shall be inspected carefully. Any concrete or mortar that has sealed across the joint shall be cut neatly and removed.

(e) Special Joints: Special water-tight and flashed expansion joints shall be constructed as shown on the plans.

### 5.22 Curing Concrete:

Careful attention shall be given by the contractor to the proper curing of finished concrete surfaces. Such surfaces shall be protected, within twenty-four 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 ten 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 fourteen days after placing and for such additional time as may be considered advisable.

### 5.23 Removal of Forms:

In order to facilitate finishing, forms on ornamental work, railings, parapets and exposed vertical surfaces shall be removed in not less than 12 or more than 48 hours, depending upon weather conditions. Forms under beams and girders, shall remain in place at least 14 days in warm weather and in cold weather at the discretion of the engineer. Forms under floor slabs shall remain in place at least 7 days in warm weather. Forms shall always be removed from columns before

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removing shoring from beneath beams and girders in order to determine the condition of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. As soon as the forms are removed, all projecting wire or other metal devices used for holding the forms in place and which pass through the body of the concrete shall be removed or cut back at least  $\frac{1}{4}$  inch beneath the surface of the concrete and the holes or depressions thus made, and all other holes, depressions and small voids which show upon the removal of the forms, shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the work. Lips or mortar and all irregularities caused by form joints shall be removed. The presence of excessive honeycomb areas may be considered sufficient cause for the rejection of the structure, and upon written notice from the engineer, the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense. In patching holes or porous spots, all course or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick, dry mortar composed of one part of Portland cement to two parts of sand, which shall be tamped into place thoroughly. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall present a neat and workmanlike appearance. The patch shall be kept wet for a period of 5 days.

For patching large or deep areas, coarse aggregate shall be added to the patching material and special precautions shall be taken to insure a dense, well bonded and properly cured patch, all as required by the engineer.

### 5.24 Removal of Falsework:

Falsework shall not be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Falsework shall remain in place after concreting is completed at



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least 14 days in warm weather and in cold weather at the discretion of the engineer.

### 5.25 Finishing Concrete:

(a) General: All concrete surfaces exposed in the completed work shall comply with the requirements of the clause defining "Rubbed Finish" except as provided hereinafter for "Concrete Floors" and for "Curb and Sidewalk Finish."

All concrete surfaces which are not exposed in the completed work shall comply with the requirements of the clause defining "Ordinary Finish."

(b) Rubbed Finish: After the pointing has set sufficiently to permit, the exposed surfaces shall be thoroughly wetted and rubbed with a carborundum or other abrasive of equal quality to bring the surface to a smooth texture and remove all form marks. The paste formed by the rubbing as above described may be finished by carefully stripping with a clean brush, or it may be spread uniformly over the surface and allowed to take a reset, after which it shall be finished by floating with a canvas, carpet-faced or cork float or rubbed down with dry burlap.

(c) Ordinary Finish: An "Ordinary Finish" is defined as the surface left by the removal of the forms with all holes left by form ties filled and all defects repaired. The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All surfaces which cannot be repaired to the satisfaction of the engineer shall be given a "Rubbed Finish."

(d) Concrete Floor Finish: The roadway surface shall conform to the grade and cross section shown on the plans. After the deck is placed it shall be struck off with a longitudinal screed which shall be constructed of steel shapes and adjustable for sag. It shall be of sufficient length to strike off a full span or panel length in one operation. The screed shall pass over all floor surfaces a minimum of three times. The surface shall then be hand finished to produce an even riding surface by means of floats and belts. Before the concrete has taken its final set, the surface shall be tested for irregularities or waves by means of a ten foot straight edge laid parallel to the centerline of roadway. Should any point of the concrete surfaces be  $\frac{1}{8}$  inch or more below or above the straight line, such defect shall be immediately remedied.

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(e) **Curb and Sidewalk Finish:** Exposed faces of curbs and sidewalks shall be finished to true surfaces having the lines and grades shown on the plans. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete and a layer of mortar  $\frac{1}{4}$  inch thick is flushed to the top. The surface shall then be struck off to obtain a true surface and given a brush finish. The junction of the sidewalk with masonry parapets shall be finished with a fillet of  $\frac{3}{4}$  inch radius. Walk surfaces shall be laid out in squares with a grooving tool, as shown on the plans or as directed by the engineer.

(f) **Special Finishes:** The following finishes shall be used only when specifically called for on the plans.

**Ground or Terrazo Finish:** Using a number sixteen carborundum stone or an abrasive of equal quality, the surface shall be ground dry or in water until it is smooth and individual pebbles and aggregate particles are cut and polished. The surface shall then be completely cleansed with water, and the final rubbing done by means of a number thirty stone. The finished surface shall present the texture of polished marble and shall show the various aggregate particles in polished outline.

**Tooled Finish:** Finish of this character for panels and other like work may be secured by the use of a bush-hammer, 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.

**Sand Blast Finish:** This type of finish shall be similar to that above described for tooled finish, but finer grained in texture. The sand blasting must be done by means of approved equipment and in such manner as to produce an even, fine-grained surface in which the mortar has been cut away leaving the aggregate particles exposed.

### 5.26 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 pres-

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sure 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

#### 5.27 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 embedded in concrete, for all expansion joints, and for all pile heads embedded in concrete. In computing the volume to be deducted for concrete 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.

#### 5.28 Basis of Payment:

The number of cubic yards of completed and accepted concrete, of the several classes, measured as provided above, shall

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be paid for at the contract price per cubic yard for Class "A," Class "D," 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 installation of all joints, weep-holes, and cast iron drains and for all timber bumpers, forms, falsework, placing and finishing, and 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.

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 "S" Concrete, per cubic yard.

## SECTION 6

### REINFORCING STEEL

#### 3.01 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. The form of the bars shall be such as to maintain a net section equivalent to a plain square or round bar of equal nominal size.

The use of cold twisted bars will not be permitted.

The use of rail steel bars will not be permitted.

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(b) Concrete Paving: Reinforcing steel for concrete paving shall be plain or deformed bars, either of billet or rail steel, or fabric reinforcement, as indicated on the plans.

MATERIALS

6.02 Billet Steel:

(a) Material Covered: These specifications cover two classes of billet-steel concrete reinforcement bars: namely, plain and deformed.

Plain and deformed bars are of two grades: namely, structural steel and intermediate.

(b) Manufacture: The steel shall be made by one or more of the following processes: open-hearth, electric furnace or acid bessemer.

The bars shall be rolled from new billets of properly identified heats of open-hearth or electric furnace steel, or lots of acid bessemer steel. No rerolled material will be accepted.

(c) Chemical Properties and Tests:

1. Composition: The steel shall conform to the following requirements as to chemical composition:

Phosphorus, max., per cent:

Acid-bessemer ..... 0.10

Open-hearth or electric furnace—

Basic ..... 0.05

Acid ..... 0.08

2. Analyses: An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus and sulfur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and the percentage of phosphorous shall conform to the requirement specified in paragraph 1. Analysis may be made by the purchaser from finished bars representing each melt of open-hearth or electric-furnace steel, and each melt or lot of ten tons of bessemer steel. The phosphorus content thus determined shall not exceed that specified in paragraph 1 by more than 25 per cent.

3. Rejection: Unless otherwise specified, any rejection based on the above tests shall be reported within five days from receipt of sample. Samples which represent rejected bars shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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(d) Physical Properties and Tests:

1. The bars shall conform to the following requirements as to tensile properties:

TENSILE REQUIREMENTS

<i>Properties Considered</i>	<i>Plain Bars</i>			<i>Deformed Bars</i>		
	<i>Structural Steel Grade</i>	<i>Intermediate Grade</i>	<i>Hard Grade</i>	<i>Structural Steel Grade</i>	<i>Intermediate Grade</i>	<i>Hard Grade</i>
Tensile strength lb. per sq. in. ....	55,000 to 70,000	70,000 to 90,000	80,000 min.	55,000 to 70,000	70,000 to 90,000	80,000 min.
Yield point, min. lbs. per sq. in. ....	33,000	40,000	50,000	33,000	40,000	50,000
Elongation in 8 in. min. per cent. ....	1,400,000* Tensile Strength	1,300,000* Tensile Strength but not less than 16%	1,200,000* Tensile Strength	1,250,000* Tensile Strength	1,125,000* Tensile Strength but not less than 14%	1,000,000* Tensile Strength

\*See paragraph 2 following.

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The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine.

2. Modification in Elongation: For plain and deformed bars over  $\frac{3}{4}$  inch in thickness or diameter, a deduction from the percentages of elongation specified in paragraph 1 of 0.25 per cent shall be made for each increase of  $\frac{1}{32}$  inch of the specified thickness or diameter above  $\frac{3}{4}$  inch.

For plain and deformed bars under  $\frac{7}{16}$  inch in thickness or diameter, a deduction from the percentages of elongation specified in paragraph 1 of 0.5 per cent shall be made for each decrease of  $\frac{1}{32}$  inch of the specified thickness or diameter below  $\frac{7}{16}$  inch.

3. Bending Properties: The test specimen shall stand being bent cold around a pin without cracking. The following requirements for degree of bending and sizes of pins shall be observed.

BEND TEST REQUIREMENTS

Thickness or Diameter of Bar	PLAIN BARS			DEFORMED BARS		
	Structural Steel Grade	Inter-med. Grade	Hard Grade	Structural Steel Grade	Inter-med. Grade	Hard Grade
Under $\frac{3}{4}$ inch.....	180° d = t	180° d = 2t	180° d = 3t	180° d = t	180° d = 3t	180° d = 4t
$\frac{3}{4}$ inch or Over.....	180° d = t	90° d = 2t	90° d = 3t	180° d = 2t	90° d = 3t	90° d = 4t

Explanatory Note: d = the diameter of pin about which the specimen is bent.  
t = the thickness or diameter of the specimen.

Bend tests shall be made on specimens of sufficient length to insure free bending and with apparatus which provides:

Continuous and uniform application of force throughout the duration of the bending operation.

Unrestricted movement of the specimen at points of contact with the apparatus.

Close wrapping of the specimen about the pin or mandrel during the bending operation.

Other methods of bend testing may be used but failure due to such methods shall not constitute a basis for rejection.

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4. Tension and Bend Test Specimens: Tension and bend test specimens from plain or deformed bars shall be of the full section of bars as rolled. For tension tests of deformed bars the sectional area used for unit stress determination shall be calculated from the length and weight of the test piece. Note: The area in square inches may be calculated by dividing the weight per linear inch of specimen in pounds by 0.2833 (weight of 1 cubic inch of steel), or by dividing the weight per linear foot of specimen in pounds by 3.4 (weight of steel 1 inch square, 1 foot long).

5. Permissible Variations in Weight: The weight of any lot (see note) of bars shall not vary more than 3½ per cent over or under the theoretical weight for bars ¾ inch and over in diameter; nor more than 5 per cent over or under for bars under ¾ inch in diameter. The weight of any individual bar shall not vary more than 6 per cent under the theoretical weight for bars ¾ inch and over in diameter; nor more than 10 per cent under the theoretical weight for bars under ¾ inch in diameter. The theoretical weight of deformed bars shall be the theoretical weight of plain round or square bars of the same nominal size.

6. Finish: The finished bars shall be free from injurious defects and shall have a workmanlike finish.

7. Marking: The brand of the manufacturer shall be legibly rolled on all deformed bars, and when loaded for mill shipment, all bars shall be properly separated and tagged with the manufacturer's test identification number.

8. Testing: All physical tests of bars shall be made at the laboratories of the Commission unless otherwise specified. Testing of billet-steel bars shall be in accordance with A. S. T. M. Designation E 8-36.

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 to the Commission testing laboratory for testing purposes. Contractor shall ship one extra main girder bar, of each size with each 30 ton consignment containing these bars, to provide test specimens, as no splicing of these bars is permitted.

If any specimen develops flaws, it may be discarded and another specimen substituted.

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Note: The term "lot" used in this paragraph means all the bars of the same nominal weight per linear foot in a carload.



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If the percentage of elongation of any tension test specimen is less than that specified in paragraph 1 and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

**6.03 Rail-Steel:**

(a) Material Covered: These specifications cover two classes of rail-steel concrete reinforcement bars: namely, plain and deformed.

(b) Manufacture: The bars shall be rolled from standard section Tee rails. No other materials, such as those known by terms of "rerolled," "rail-steel equivalent," and "rail-steel quality," shall be substituted.

(c) Physical Properties and Tests:

1. Tensile Properties: The bars shall conform to the following minimum requirements as to tensile properties:

	Plain Bars	Deformed Bars
Tensile strength, lbs. per square inch .....	80,000	80,000
Yield point, lbs. per square inch....	50,000	50,000
	1,200,000*	1,000,000*
Elongation in 8 inches, per cent	—————	—————
	tens.str.	tens.str.

\*See paragraph 2 following.

The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine.

2. Modifications in Elongation: For bars over  $\frac{3}{4}$  inch in thickness or diameter, a deduction from the percentages of elongation specified in paragraph 1 of 0.25 per cent shall be made for each increase of  $\frac{1}{32}$  inch of one specified thickness or diameter above  $\frac{3}{4}$  inch.

For bars under  $\frac{7}{16}$  inch in thickness or diameter, a deduction from the percentages of elongation specified in paragraph 1 of 0.5 per cent shall be made for each decrease of  $\frac{1}{32}$  inch of the specified thickness or diameter below  $\frac{7}{16}$  inch.

3. Bending Properties: The test specimen shall stand being bent cold around a pin without cracking. The following re-

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quirements for degree of bending and sizes of pins shall be observed:

Thickness or Diameter of Bar	Plain Bars	Deformed Bars
Under $\frac{3}{4}$ inch .....	$180^\circ d=3t$	$180^\circ d=4t$
$\frac{3}{4}$ inch or over .....	$90^\circ d=3t$	$90^\circ d=4t$

(d—the diameter of pin about which the specimen is bent; t—the thickness or diameter of the specimen.)

Bend test shall be made on specimens of sufficient length to insure free bending and with apparatus which provides:

Continuous and uniform application of force throughout the duration of the bending operation.

Unrestricted movement of the specimen at points of contact with the apparatus.

Close wrapping of the specimen about the pin or mandrel during the bending operation.

Other methods of bend testing may be used but failure due to such methods shall not constitute a basis for rejection.

4. Tension and Bend Test Specimens: Tension and bend test specimens from plain or deformed bars shall be of the full section of bars as rolled. For tension test of deformed bars the sectional area used for unit stress determination shall be calculated from the length and weight of the test piece.

Note: The area in square inches may be calculated by dividing the weight per linear inch of specimen in pounds by 0.2833 (weight of 1 cubic inch of steel), or by dividing the weight per linear foot of specimen in pounds by 3.4 (weight of steel 1 inch square, 1 foot long.)

5. Permissible Variations in Weight: The weight of any lot (see note) of bars shall not vary more than  $3\frac{1}{2}$  per cent over or under the theoretical weight for bars  $\frac{3}{8}$  inch and over in diameter; nor more than 5 per cent over or under for bars under  $\frac{3}{8}$  inch in diameter. The weight of any individual bar shall not vary more than 6 per cent under the theoretical weight for bars  $\frac{3}{8}$  inch and over in diameter; nor more than 10 per cent under the theoretical weight for bars under  $\frac{3}{8}$  inch in diameter. The theoretical weight of deformed bars shall be the theoretical weight of plain round or square bars of the same nominal size.

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Note: The term "lot" used in this paragraph means all the bars of the same nominal weight per linear foot in a carload.

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6. Finish: The finished bars shall be free from injurious defects and shall have a workmanlike finish.

7. Testing: All physical tests of bars shall be made at the laboratory of the Commission, unless otherwise specified. Testing of bars shall be in accordance with A. S. T. M. Designation E 8-36.

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 to the Commission testing laboratory for testing purposes.

If any specimen develop flaws, it may be discarded and another specimen substituted.

If the percentage of elongation of any tension test specimen is less than that specified in paragraph 1 and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

**6.04 Cold-Drawn Steel Wire for Concrete Reinforcement:**

(a) Material Covered: These specifications cover cold-drawn steel wire to be used as such, or in fabricated form, for the reinforcement of concrete, in gages not less than 0.080 inch nor greater than 0.625 inch.

When wire is ordered by gage number the following relation between number and diameter, in inches, shall apply unless otherwise specified:

Gage Number	Diameter in Fraction of Inch	Gage Number	Diameter in Fraction of Inch
0000000.....	0.4900	5.....	0.2070
000000.....	0.4615	6.....	0.1920
00000.....	0.4305	7.....	0.1770
0000.....	0.3938	8.....	0.1620
000.....	0.3625	9.....	0.1483
00.....	0.3310	10.....	0.1350
0.....	0.3065	11.....	0.1205
1.....	0.2830	12.....	0.1055
2.....	0.2625	13.....	0.0915
3.....	0.2437	14.....	0.0800
4.....	0.2253		

(b) Manufacture: The steel shall be made by one or more of the following processes: open-hearth, electric furnace or acid bessemer.

The wire shall be cold drawn from rods hot-rolled from billets.

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(c) Physical Properties and Tests:

1. Tensile Properties: The wire, except as specified below under wire for mesh and wire testing over 100,000 pounds per square inch tensile strength, shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch.....	80,000
Yield point, per cent of observed tensile strength	80
Reduction of area, per cent.....	30

For wire to be used in the fabrication of mesh a minimum tensile strength of 70,000 pounds per square inch shall be permitted.

The yield points shall be determined by the drop of the beam or halt in the gage of the testing machine. In case no definite drop of the beam or halt in the gage is observed until final rupture occurs, the test shall be construed as meeting the requirement for yield point shown in above table.

For wire testing over 100,000 pounds per square inch tensile strength, the reduction of area shall be not less than 25 per cent.

2. Bending Properties: The test specimen shall stand being bent cold through 180 degrees without cracking on the outside of the bent portion, as follows:

For wire 0.3 inch in diameter or under, a round pin the diameter of which is equal to the diameter of the specimen.

For wire over 0.3 inch in diameter, around a pin the diameter of which is equal to twice the diameter of the specimen.

3. Tension and Bend Test Specimens: Tension and bend test specimens shall be of the full size section of the wire as drawn.

4. Permissible Variations in Gage: The dimensions of the wire, on any diameter, shall not vary more than 0.003 inch from the specified nominal diameter. The difference between the maximum and minimum diameters, as measured on any given cross section of the wire, shall not be greater than 0.003 inch.

5. Finish: The finished wire shall be free from injurious defects and shall have a workmanlike finish with smooth surface.

6. Testing: Tests of steel wire shall be made at the laboratory of the Commission, unless otherwise specified.

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After the steel is delivered to the site, the engineer shall select one sample, 36 inches by 36 inches from each carload or less, and forward to the Commission testing laboratory for testing purposes.

If any specimen shows defects or develops flaws, it may be discarded and another specimen substituted.

(d) Fabrication: Wire fabric reinforcement shall be of a series of longitudinal wires combined with a series of transverse wires arranged at right angles thereto and electrically welded at all points of intersection. The size and spacing of wires in the fabric shall be as shown on the plans. Welds shall be of sufficient strength that they will not be broken during handling or placing.

Reinforcing fabric shall be furnished in flat sheets. Any sheets that may have 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 impair its bond with the concrete.

## CONSTRUCTION METHODS

### 6.05 General Requirements:

(a) 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, rust, loose mill scale and dust, which is easily removable, it may be cleaned by a satisfactory method if approved by the engineer.

(b) 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.

(c) Bending: When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected.

### 6.06 Structures:

(a) Placing and Fastening: All reinforcement shall be accurately placed in the exact position shown on the plans and shall be so securely held in position by wiring and blocking from the forms and by wiring together at intersections so

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that it will not be displaced during the depositing and compacting of the concrete. Blocks for holding reinforcement from contact with forms and for separating layers of bars shall be precast mortar blocks of approved shape and dimensions.

The use of pebbles, pieces of broken stone or brick, metal pipes and wooden blocks shall not be permitted.

(b) Splices: All reinforcement bars shall be furnished in the full length shown on the plans. No splicing of bars, except where shown on the plans, will be permitted without the written approval of the engineer. In no case will splicing of main girder bars be permitted.

Splices which are permitted shall not be located at points of maximum stress; they shall, where possible, be staggered; and they shall have a length of not less than 50 times the nominal diameter of the bars. The bars shall be rigidly clamped or wired at all splices in a manner approved by the engineer.

(c) Welding: No welds will be permitted.

### 6.07 Concrete Pavement:

Reinforcing bars and fabric reinforcement shall be placed in accordance with the directions specified under "Portland Cement Concrete Pavement."

## MEASUREMENT AND PAYMENT

### 6.08 Method of Measurement:

(a) Reinforcement in Structures: Reinforcing steel placed and accepted in structures, including counterweights, will be measured by the pound, theoretical weight, complete in place.

For the purpose of computing the weight of reinforcing bars in structures the following table of unit weights shall be used:

#### TABULATION OF WEIGHTS OF REINFORCING BARS

$\frac{3}{8}$ Inch Round	—0.376 lbs. per foot
$\frac{1}{2}$ Inch Round	—0.668 lbs. per foot
$\frac{1}{2}$ Inch Square	—0.850 lbs. per foot
$\frac{5}{8}$ Inch Round	—1.043 lbs. per foot
$\frac{3}{4}$ Inch Round	—1.502 lbs. per foot
1 Inch Round	—2.670 lbs. per foot
1 Inch Square	—3.400 lbs. per foot
$1\frac{1}{8}$ Inch Square	—4.303 lbs. per foot
$1\frac{1}{4}$ Inch Square	—5.313 lbs. per foot

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No measurement of reinforcing steel in concrete piling will be made.

No measurement of reinforcing steel furnished for testing purposes will be made.

(b) Reinforcement in Concrete Pavement: Reinforcing steel placed and accepted in concrete pavement will be measured by the pound, complete in place. In computing the weight of reinforcing steel or fabric reinforcement in pavement, the product of the area of the pavement slab reinforced multiplied by the weight per unit of area shown on the plans will be used.

No measurement of reinforcing steel furnished for testing purposes will be made.

### 6.09 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," "Bar Reinforcement" or "Fabric Reinforcement," as the case may be, which price and payment shall constitute full compensation for furnishing, bending, delivering and placing all 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, Bar Reinforcement, (Concrete Pavement) per pound.

Item 4-6-4, Fabric Reinforcement, per pound.

## 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

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these features for which other payment is provided), all in accordance with these specifications and with applicable requirements prescribed for "Steel Bridges," "Concrete Bridges," "Concrete" and "Painting" and in conformity with the dimensions, shapes and designs shown on the plans.

### MATERIALS

#### 7.02 Structural and Rivet Steels:

Except where otherwise provided, all members of steel structures shall be of structural steel and rivets shall be of rivet steel. All structural steel, except where alloy steel is specified, shall conform to the requirements of the Standard Specifications for Steel for Bridges, A. S. T. M. Designation A 7-36, and all rivet steel shall conform to the requirements of the Standard Specifications for Structural Rivet Steel, A. S. T. M. Designation A 141-36. These requirements shall apply with the subsequent amendments and additions thereto adopted by the A. S. T. M., but are supplemented by the following requirements:

(a) Character of Fracture: Test specimens of structural, or rivet steel shall show a fracture having a silky or fine granular structure throughout, with a bluish gray or dove color, and shall be entirely free from granular black and brilliant specks.

(b) Defects in Material: Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects, provided, however, that surface imperfections in material  $\frac{3}{8}$  inch or more in thickness may be corrected in the following manner.

When the imperfections are less than  $\frac{1}{16}$  inch in depth, they may be removed by grinding. When the imperfections are  $\frac{1}{16}$  inch or more in depth, they shall be chipped and, unless otherwise permitted by the engineer, they shall be welded in accordance with this specification.

The maximum depth of any depression after chipping shall not exceed the following:

- 1/16 inch in metal from 0.375 to 0.499 inch in thickness.
- $\frac{1}{8}$  inch in metal from 0.500 to 0.999 inch in thickness.
- $\frac{3}{16}$  inch in metal from 1.000 to 1.499 inches in thickness.
- $\frac{1}{4}$  inch in metal from 1.500 to 2.249 inches in thickness.
- $\frac{3}{8}$  inch in metal from 2.250 to 3.500 inches in thickness.

The cross-sectional area shall not be reduced at any point



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in its length more than 1.5 per cent by the removal of the defects.

After removal of the defects and before any welding is done, the material shall be subject to inspection by the engineer. All welding shall be done in the presence of the engineer. This inspection may be waived only upon written authorization of the engineer.

Upon approval of the chipped areas or upon written waiver of inspection by the engineer, weld metal shall be deposited in the depression to a thickness extending at least 1/16 inch above the rolled surface. The welders shall be qualified for the work and flux coated welding rods suitable to the grade of steel shall be used.

The deposited weld metal shall be sound and free from excessive oxides, non-metallic inclusions and gas pockets. It shall penetrate every recess in the rolled metal and shall be thoroughly fused with it on all surfaces and edges of fusion. Along the edge of the deposit, the weld metal shall merge into the metal with a gradual taper and shall have no re-entrant projection or overlap.

In the welding operation, the metal shall not be undercut along the edges of the welded area. All metal projecting above the rolled surface after welding shall be removed by chipping or grinding to produce a workmanlike finish.

All material shall be free from loose mill scale, rust pits or other defects affecting its strength.

### 7.03 Structural Silicon Steel:

Silicon steel shall conform to the requirements of the Standard Specifications for Structural Silicon Steel, A. S. T. M. Designation A 94-36 with subsequent amendments and additions thereto adopted by the A. S. T. M.

### 7.04 Steel Forgings: *has been amended*

(a) Process: Steel for forgings from which pins, rollers, trunnions or other forged parts are to be fabricated, shall be made by either or both the following processes: Open hearth or electric furnace.

(b) Discard: A discard shall be made from each ingot sufficient to secure freedom from injurious piping and undue segregation.

(c) Prolongation for Tests: Unless otherwise specified, not less than 20 per cent of the forgings shall be provided with elongations for test purposes or, at the manufacturer's option, a forging may be selected.

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(d) Chemical Composition and Tests:

1. Composition: The steel shall conform to the following requirements as to chemical composition:

Manganese, per cent.....	0.4 to 0.80
Phosphorus, per cent	{ Acid, not over. 0.05
	{ Basic, not over 0.05
Sulphur, per cent, not over.....	0.05

2. Ladle Analyses: An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot secured during the pouring of the melt. The chemical composition thus determined shall be reported to the engineer and, if it fails to conform to the required chemical composition, the melt shall be rejected.

3. Check Analyses: An analysis may be made by the engineer from a forging representing each melt. The chemical composition thus determined shall conform to the requirements specified. Drillings for analysis may be taken from the forgings or from a full-size prolongation thereof, at any point midway between the inner and the outer surfacing of the wall of bored forgings, or turnings may be taken from a test specimen.

(e) Annealing:

1. Process: Forgings shall be annealed. The procedure shall be as follows: Allow the objects, immediately after forging, to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling; then reheat uniformly to a proper temperature to refine the grain and allow to cool uniformly. A group of objects thus simultaneously reheated and cooled constitutes an annealing charge.

2. Record of Annealing: A record of the annealing charges shall be furnished the engineer showing the forgings in each charge, the melt or melts from which they were secured, and the treatment they received.

(f) Physical Properties and Tests:

1. Tensile Properties: The forgings, after annealing, shall conform to the following requirements:

Tensile strength, minimum pounds	
per sq. in. ....	60,000
Yield point, pounds per sq. in.....	0.5 tensile strength
but not less than .....	33,000

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Elongation in 2 in., min.,  
per cent

Forgings having a maximum out-  
side diameter or over-all thick-  
ness of not over 12 in.....1,700,000 not under 25  
Ten. Str.

Forgings having a maximum out-  
side diameter or over-all thick-  
ness over 12 in. to 20 in.,  
inclusive .....1,600,000 not under 24  
Ten. Str.

Reduction of Area, min.,  
per cent

Forgings having a maximum out-  
side diameter or over-all thick-  
ness of not over 12 in.....1,700,000 not under 38  
Ten. Str.

Forgings having a maximum out-  
side diameter or over-all thick-  
ness over 12 in. to 20 in.,  
inclusive .....2,500,000 not under 36  
Ten. Str.

2. Classification: the classification of forgings by size shall be determined by the diameter or thickness of the prolongation from which the test specimen is taken.

Tests of forgings shall be made only after the final treatment.

3. Speed of Testing Machine: The crosshead of the testing machine shall move at a speed insuring uniformity in the application of the load and accuracy in its determination. It shall not exceed the limits specified in Methods of Tension Testing of Metallic Materials, A. S. T. M. Designation E 8-36.

The yield point shall be determined by the drop of the beam or the halt in the gage of the machine.

4. Tension Test Specimens: Tension test specimens shall be taken from a full-size prolongation of a forging. For forgings with large ends or collars, the prolongation may be of the same cross section as that of the forging back of the end or collar. Specimens may be taken from the forging itself with a hollow drill, if approved by the engineer.

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The axis of the specimen may be located at any point midway between the center and the surface of a solid forging, and at any point midway between the inner and the outer surfaces of the wall of a bored forging, and shall be parallel to the direction in which the metal of the forging is most drawn out.

Tension test specimens shall conform to the dimensions shown in Figure 9, Standard 2-inch Gage Length Tension Test Specimen, Methods of Tension Testing of Metallic Materials, A. S. T. M. Designation E 8-36.

5. Number of Tests: Tests shall be made as follows: One tension test shall be made from each annealing charge, except that when more than one melt is involved in an annealing charge, one tension test shall be made from each melt.

When more than one class of forgings by size is involved in an annealing charge, one tension test from a forging of each class shall be made.

When a test specimen shows defective machining or develops flaws it may be discarded and another specimen substituted.

6. Retests: When the percentage of elongation of a test specimen is less than that specified and any part of the fracture is more than  $\frac{3}{4}$  inch from the center of the gage length, as indicated by scribe scratches marked upon the specimen before testing, a retest shall be made.

When the result of the test of an annealing charge fails to conform to the requirements specified, the manufacturer may reanneal the charge one or more times and following each annealing treatment, test specimens shall be made and tested as hereinbefore described.

(g) Workmanship and Finish: The forgings shall be free from injurious defects, shall conform to the required sizes and shapes and shall have a workmanlike finish.

(h) Identification Marks: Identification marks shall be stamped legibly on each forging and on each test specimen.

(i) Inspection: The engineer shall be allowed free access at all times to the parts of the works involved in the manufacture of the material ordered, while work thereon is in progress. The manufacturer shall without charge, provide the facilities for making inspections, shall furnish the required number of test specimens and, unless otherwise provided, shall provide the testing laboratory facilities, including labor, necessary to make the tests.

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Inspection and tests (except check analyses) shall be made at the place of manufacture before shipment unless otherwise provided, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests made by the Commission in its laboratory or elsewhere shall be made without expense to the contractor.

(j) Rejection: Unless otherwise provided, any rejection based upon test made by the Commission in its laboratory or elsewhere shall be reported within five days from the receipt of the specimens.

Specimens representing forgings rejected as a result of tests made by the Commission in its laboratory or elsewhere shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results, the manufacturer shall be allowed a rehearing within that time.

Forgings in which injurious defects are discovered subsequent to their acceptance at the works will be rejected and the manufacturer so notified.

**7.05 Wrought Iron:** *See omitted*

Wrought iron shall conform to the requirements of the Standard Specifications for Refined Wrought Iron Bars, A. S. T. M. Designation A 41-36, with subsequent amendments and additions thereto adopted by the A.S.T.M.

**7.06 Steel Castings:** *See omitted*

(a) Process: The steel shall be made by one or more of the following processes: open-hearth, electric furnace, converter, or crucible.

(b) Chemical Composition and Tests:

1. Composition: The steel shall conform to the following requirements as to chemical composition:

Manganese, per cent .....	0.50 to 1.00
Phosphorus, per cent .....	not over 0.05
Sulphur, per cent .....	not over 0.06
Silicon, per cent .....	0.20 to 0.75

2. Ladle Analyses: An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur and silicon. This analysis shall be made from drillings taken at least ¼ inch beneath the surface of a test ingot secured during the pouring of the melt. The chemical composition thus determined shall be reported to the engineer and, if it fails to conform to the required chemical composition, the melt shall be rejected.

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3. Check Analyses: An analysis may be made by the engineer from a broken tension test specimen or from a casting representing each melt. The chemical composition thus determined shall conform to the requirements specified. Drillings for analysis shall be taken at least  $\frac{1}{4}$  inch beneath the surface.

(c) Annealing:

1. Process: All castings shall be annealed unless otherwise provided. The procedure shall be as follows: After pouring, allow the castings to cool to a temperature below the critical range, then reheat uniformly to a proper temperature and for the required time, to refine the grain, and allow to cool slowly in the furnace until the pyrometer shows that the furnace temperature has fallen to 500° F. The furnace temperature shall be controlled effectively by pyrometers.

2. Record of Annealing: A record of the annealing charges shall be furnished the engineer showing the castings in each charge, the melt or melts from which they were secured, and the treatment they received.

(d) Physical Properties and Tests:

1. Tensile Properties: The castings, after annealing, shall conform to the following requirements:

Tensile strength, pounds per square inch.....	70,000
Yield point, minimum pounds per square inch....	38,000
Elongation in 2 inches, minimum per cent .....	24
Reduction of area, minimum per cent.....	36

2. Speed of Testing Machines: The requirements of this article shall be the same as for steel forgings, of these specifications.

3. Tension Test Specimens: Tension test specimens shall be taken from test bars cast attached to the castings, or, if in the judgment of the manufacturer, the design of the castings is such that test bars attached directly to the castings might affect the castings or the test specimens injuriously, the test bars shall be cast attached to special blocks. Test bars from which tension test specimens are to be taken shall remain attached to the castings or blocks while being annealed and until presented for inspection.

Test bars shall be provided in sufficient numbers to fulfill the requirements as given below.

Tension test specimens shall conform to the dimensions shown in Figure 9, Standard 2-inch Gage Length Tension Test Specimen, Methods of Tension Testing of Metallic Materials, A.S.T.M. Designation E 8-36.

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4. Number of Tests: Tests shall be made as follows: One tension test shall be made from each annealing charge, except that when more than one melt is involved in an annealing charge, one test shall be made from each melt. When so specified, one tension test shall be made from each casting weighing 500 pounds or more.

When a test specimen shows defective machining or develops flaws, it may be discarded and another specimen from the same charge and melt substituted.

5. Retests: When the percentage of elongation of a test specimen is less than that specified and any part of the fracture is more than  $\frac{3}{4}$  inch from the center of the gage length, as indicated by scribe scratches marked upon the specimen before testing, a retest shall be made.

When the results of the test of an annealing charge fail to conform to the requirements specified, the manufacturer may reanneal the charge, but not more than twice; and following each annealing treatment, test specimens shall be made and tested as hereinbefore described.

(e) Workmanship and Finish: Steel castings shall be true to pattern in form and dimensions without sharp, unfilleted angles or corners, and shall be free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

Blow holes appearing upon finished castings shall be so located that a straight line laid in any direction will not cut a total length of cavity greater than 1 inch in any 1 foot, nor shall any single blow hole exceed 1 inch in any dimension or have an area greater than  $\frac{1}{2}$  square inch.

Blow holes shall not have a depth injuriously affecting the strength of the castings. Minor defects which do not impair the strength may, with the approval of the engineer, be welded by an approved process. The defects shall be removed to solid metal by chipping, drilling, or other satisfactory methods and, after welding, the casting shall be annealed, if required by the engineer. Castings which have been welded without the permission of the engineer shall be rejected.

If required by the engineer, large castings shall be suspended and hammered all over. No cracks, flaws, or other defects shall appear after such treatment.

(f) Identification Marks: The name or brand of the manufacturer and the pattern number shall be cast, when practicable, in each casting. The melt number shall be stamped lightly on each casting and each test specimen.

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(g) Inspection: The engineer shall be allowed free access at all times to the parts of the works involved in the manufacture of the castings, while the work thereon is in progress. The manufacturer shall, without charge, provide the facilities for making inspections, shall furnish the required number of test specimens and, unless otherwise provided, shall provide the testing laboratory facilities, including labor, necessary to make the tests.

Inspections and tests (except check analysis) shall be made at the place of manufacture before shipment, unless otherwise provided, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests made by the Commission in its laboratory or elsewhere shall be made without expense to the contractor.

(h) Rejection: Unless otherwise provided, any rejection based upon tests made by the Commission in its laboratory or elsewhere shall be reported within five days from the receipt of the specimens.

Specimens representing castings rejected as a result of tests made by the Commission in its laboratory or elsewhere shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the result, the manufacturer shall be allowed a rehearing within that time.

Castings in which injurious defects are discovered subsequent to their acceptance at the work will be rejected and the manufacturer so notified.

### 7.07 Gray-Iron Castings: *see amended*

(a) General: Iron castings shall conform to the requirements of the Standard Specifications for Gray-Iron Castings, A.S.T.M. Designation A 48-36, with subsequent amendments and additions thereto adopted by the A.S.T.M.

Castings shall be boldly filleted at angles, and the arrises shall be sharp and perfect.

(b) Structural Defects: 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 service intended.

### 7.08 Malleable Castings:

(a) General: Malleable castings shall conform to the requirements of the Standard Specifications for Malleable Castings, A. S. T. M. Designation A 47-33, with subsequent amendments and additions thereto adopted by the A. S. T. M.



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The castings shall be boldly filleted at angles and arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

(b) Structural Defects: 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.

### 7.09 Bronze Castings:

Bronze castings shall conform to the requirements of the Tentative Specifications for Bronze Castings for Turntables and Movable Bridges, A. S. T. M. Designation B 22-36T, Class C.

### 7.10 Rolled Bronze Plates:

Rolled bronze shall conform to the requirements of the Tentative Specifications for Wrought Phosphor Bronze Bearings and Expansion Plates for Bridges and Structures, A. S. T. M. Designation B 100-35T, Class A.

### 7.11 Paint:

All paint materials shall comply with the requirements under "Painting."

## CONSTRUCTION METHODS

### 7.12 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 sheet and specifications, and no deviation 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. Three sets of blue print copies shall be submitted to the engineer 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 copy of blueprints submitted by underscoring with col-

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ored crayon or other suitable means. For final approval, the contractor shall submit seven blue print copies. Upon completion of fabrication, the original tracings shall be delivered to the engineer. No additional payment will be made for these plans, the cost thereof shall be considered as included in the price bid for steel.

(b) Quality of Workmanship: Workmanship and finish shall be equal to the best general practice in modern bridge shops.

(c) Storage of Material: Structural material, either plain or fabricated, 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 practicable from corrosion. It shall be kept properly drained.

(d) 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 may be cause for rejection of the material.

(e) Finish: Portions of the work exposed to view shall be finished neatly. Shearing and chipping shall be done carefully and accurately.

### (f) Rivet Holes:

1. Punched Work: If general reaming is not required, all main material, forming parts of a member composed of not more than 5 thicknesses of metal may be punched with a punch  $1/16$  inch larger than the nominal size of the rivets, whenever the thickness of the metal is not greater than  $3/4$  inch. When there are more than 5 thicknesses, or when any of the main material is thicker than  $3/4$  inch, all of the holes shall be punched with a punch  $3/16$  inch smaller, and after assembling reamed  $1/16$  larger than the nominal size of the rivets, except that when the metal is thicker than the size of the rivet, the holes shall be drilled.

2. Punched Holes: Holes punched full side shall be  $1/16$  inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than  $3/32$  inch. Holes shall be clean cut and without torn or ragged edges. If any holes must be enlarged to admit rivets they shall be reamed.

3. Accuracy of Punched Holes: The punching of holes shall be done so accurately that, after assembling the com-

$$\frac{15}{16} + \frac{3}{16} = \frac{3}{4}$$

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ponent parts of a member, a cylindrical pin  $\frac{1}{8}$  inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes. If this requirement is not fulfilled, the badly punched pieces may be rejected. If 10 per cent of any group of 100 or fewer holes will not pass a pin  $\frac{3}{16}$  inch smaller than the nominal diameter of the punched hole, the mispunched pieces may be rejected.

4. General Reaming: General reaming will be required if provided for in the contract. If general reaming is required, holes shall be sub-punched and reamed in material forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes may be punched full size in material used for lateral, longitudinal and sway bracing, lacing bars, stay plates and diaphragms, not forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes shall be drilled in material the thickness of which is greater than the nominal diameter of the rivet.

5. Sub-punched Holes: Sub-punched and reamed holes for rivets having diameters greater than  $\frac{3}{4}$  inch shall be punched  $\frac{3}{16}$  inch smaller than the nominal diameter of the rivet. For rivets having diameters  $\frac{3}{4}$  inch, the holes shall be punched  $\frac{11}{16}$  inch in diameter. For rivets having diameters of  $\frac{5}{8}$  inch or less, the holes shall be punched full size and spear-reamed. The punch and die shall have the same relative sizes as specified for full size punched holes. After assembling, sub-punched holes shall be reamed to a diameter  $\frac{1}{16}$  inch larger than the nominal diameter of the rivet. Reaming shall be done after the pieces forming a built member are assembled and firmly bolted together. Reamed parts shall not be interchanged.

Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers, preferably, shall not be directed by hand. If oil or grease is used as a lubricant when reaming, it shall be applied so as not to soil surfaces which are to be painted. Burrs resulting from reaming shall be removed.

6. Drilled Holes: Drilled holes shall be  $\frac{1}{16}$  inch larger than the nominal diameter of the rivet. If members are drilled while assembled, the parts shall be securely held together

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while the drilling is being done. Burrs on the outside surfaces shall be removed.

7. Accuracy of Reamed or Drilled Holes: Reamed or drilled holes shall be cylindrical and perpendicular to the member. After reaming or drilling, 85 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes, shall not show an offset greater than  $1/32$  inch between adjacent thicknesses of metal.

(g) Shop Assembly: 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, rivet holes, if necessary, shall be spear-reamed for admission of rivets. The reamed holes shall not be more than  $3/32$  inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be adjusted carefully to correct position and bolted, clamped, or otherwise held firmly in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage to shipment and handling.

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.

If general reaming is required, riveted trusses and skew portals shall be assembled in the shop, the parts adjusted to line and fit, and holes for field connections drilled or reamed while so assembled. Holes for other field connections, except those for lateral, longitudinal and sway bracing shall be drilled or reamed in the shop with the connecting parts assembled, or else drilled or reamed to a metal template without assembling.

The field connections in punched work, except those for lateral, longitudinal and sway bracing, shall be reamed to a metal template or else with the parts assembled.

(h) Match-Marking: Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be

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match-marked and a diagram showing such marks shall be furnished to the engineer.

(i) Rivets: Rivets before driving shall be of the diameter specified. They shall be free from furnace scale. Rivet heads shall be of approved shape, concentric with the shank, true to size, full, neatly formed and free from fins.

Bolted connections shall not be used unless specifically authorized. If bolted connections are permitted, the bolts shall be unfinished bolts, or turned bolts, as specified. Bolts shall have hexagonal heads and nuts and shall be of such length that they will extend entirely through the nut but not more than  $\frac{1}{4}$  inch beyond. Bolts in tension shall have two nuts. Unfinished bolts in shear shall have not more than one thread within the grip. The diameter of the unfinished bolt shall not be more than  $\frac{1}{16}$  inch smaller than the diameter of the hole. The threads of turned bolts shall be entirely outside the grip. The bolts shall be given a finishing cut. Approved nut locks or flat washers  $\frac{1}{4}$  inch thick shall be furnished, as required. The holes for turned bolts shall be reamed and their diameters shall be not more than  $\frac{1}{32}$  inch greater than the diameter of the finished bolt.

(j) Riveting: Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale and other adhering matter. When driven, they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member. Loose, burned or otherwise defective rivets shall be replaced. In removing rivets, care shall be taken not to injure the adjacent metal and, if necessary, they shall be drilled out. Caulking or recupping will not be permitted.

Countersinking shall be neatly done, and countersunk rivets shall completely fill the holes.

Shop rivets shall be driven by direct-acting riveters, when practicable. The riveting machine shall retain the pressure for a short time after the upsetting is complete.

Pneumatic hammers shall be used for field riveting except when the use of hand tools is permitted by the engineer.

(k) Edge Planing: Sheared edges of plates more than  $\frac{5}{8}$  inch in thickness and carrying calculated stress shall be planed to a depth of  $\frac{1}{4}$  inch. Re-entrant cuts shall be filleted before cutting.

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(l) 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 and annealed. 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.

(m) 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  $\frac{1}{4}$  inch.

(n) End Connection Angles: Floorbeams, 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 be not less than shown on the detail drawings.

(o) Lacing Bars: The ends of lacing bars shall be rounded neatly unless another form is required.

(p) Finished Members: Finished members shall be true to line and free from twists, bends and open joints.

(q) 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  $\frac{1}{8}$  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  $\frac{1}{2}$  inch less in width than the distance back to back of the flange angles.

At web splices, the clearance between the ends of the web plates shall not exceed  $\frac{3}{8}$  inch. The clearance at the top and bottom ends of web splice plates shall not exceed  $\frac{1}{4}$  inch.

(r) 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

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the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within  $\frac{1}{4}$  inch at each end.

(s) Pins and Rollers: Pins and rollers shall be turned accurately to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut. Pins 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, before annealing.

(t) 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  $\frac{1}{32}$  inch. Boring of holes in built up members shall be done after the riveting is completed. The diameter of the pinhole shall not exceed that of the pin by more than  $\frac{1}{50}$  inch for pins 5 inches or less in diameter, or  $\frac{1}{32}$  inch for larger pins.

(u) Screw Threads: Screw threads shall make close fits in the nuts and shall be U. S. Standard, except that for pin ends of diameters greater than  $1\frac{1}{2}$  inches, they shall be made with 6 threads to the inch. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

(v) Welding of Steel: Welding of steel shall not be done except where shown on plans for minor details or to remedy minor defects and then only with the approval of the engineer. Defects may be corrected as and to the extent hereinbefore permitted. Structural welding, when contemplated in the fabrication, shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society, 1938.

### 7.13 Mill and Shop Inspection:

The contractor shall give the engineer ample notice of the beginning of the 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 con-

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tractor 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 and triplicate copies of shipping statements as the engineer may direct. The computed weights of the individual members shall be shown on the statements. 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.

### **7.14 Painting:**

Shop and field paints and their application shall comply with the requirements under "Painting."

### **7.15 Erection of Structural Steel:**

All structural steel shall be erected in accordance with the specifications given for this class of work, under "Steel Bridges."

### **7.16 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.

### **7.17 Cleaning-up:**

Upon completion and before final acceptance, the contractor shall remove all 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



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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

#### 7.18 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.

No allowance will be made for shop paint.

No allowance will be made for over-run on plates or rolled sections.

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

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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 "Method of Measurement," "General," necessary to complete this portion of the structure.

The weight of rivet heads shall be as given in the following table:

Diameter of Rivet. Inches...	½	⅝	¾	⅞	1	1¼	1½
Weight per 100 Heads. Lb...	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.

Plain Carbon Steel: Plain Carbon Steel shall include all steel classified as such on the contract drawings.

**7.19 Basis of Payment:**

The number of pounds of completed and accepted steel and other metal 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," or "Plain Carbon 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 merged into the unit price for "Fabricated Carbon and Silicon Steel."

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, Plain Carbon Steel, per pound.

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WEIGHT OF BOLT HEADS AND NUTS IN POUNDS PER 100

Weight of 100 each	Diameter of Bolt, Inches										
	¼	⅕	⅜	½	⅝	¾	⅞	1	1 ⅛	1 ¼	
Regular Square Heads.....	.7	1.4	2.2	3.2	5.1	10	18	29	42	60	84
Regular Hexagon Heads.....	.6	1.2	1.9	2.8	4.5	9	15	25	36	52	73
Regular Square Nuts.....	.81	1.7	2.3	4.1	5.6	10	14	23	35	49	67
Regular 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
Heavy Hexagon Heads.....					8.2	14	24	36	53	73	94
Heavy Square Nuts.....					7.9	14	23	35	50	66	92
Heavy Hexagon Nuts.....					6.6	11	19	28	41	56	73

HEAVY BOLTS

Weights of bolts over 1 ¼ 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										
	1 ½	1 ¾	2	2 ¼	2 ½	2 ¾	3	3 ¼	3 ½	3 ¾	4
Regular Square Heads.....	143	226	343	484	660	881	1148	1452	1830	2241	2710
Regular Hexagon Heads.....	124	196	297	419	577	764	994	1257	1585	1941	2350
Regular Square Nuts.....	116	184	276	391	539	666	874	1115	1401	1775	2115
Regular Hexagon Nuts.....	102	162	231	337	472	606	825	1082	1396	1789	2184
Heavy Square Heads.....	190	295	432	608	825	1087	1401	1775	2115	2715	3312
Heavy Hexagon Heads.....	162	254	377	538	727	890	1214	1526	1906	2344	2845
Heavy Square Nuts.....	154	242	355	496	674	831	1082	1396	1789	2241	2710
Heavy Hexagon Nuts.....	123	208	303	422	573	742	1008	1296	1685	2115	2584
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

**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.

The contractor shall furnish lumber of the species called for on the plans; he shall furnish timber of the species called for and of the stress-grade quality stipulated herein for the several usages.

**MATERIALS**

**8.02 General:**

(a) Treated Timber: Treated timber shall be interpreted to mean timber of the species and stress-grade called for, treated by a pressure method to retain the minimum quantity per cubic foot of the specified preservative stipulated in "Preservative Treatment for Timber." The type of preservative used shall be the type called for in the contract. Where more than one type is included in the contract, each type shall be used as indicated by the plans.

(b) Surfacing: All lumber and timber, except bulkhead planks and sway bracing shall be surfaced on four sides (S 4 S) 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:

<b>Common Names</b>	<b>Botanical Names</b>
Cypress, Tidewater Red	Taxodium distichum
Fir, Douglas (Coast)	Pseudotsuga toxifolia
Southern Yellow Pine, includes	Pinus taeda
Loblolly Pine	Pinus palustris
Longleaf Pine	Pinus rigida
Pitch Pine	Pinus serotina
Pond Pine *	Pinus echinata
Shortleaf Pine	Pinus caribaea
Slash Pine	Pinus lambertiana

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**8.04 Species and Grades to be Used:**

(a) Permanent Structures: Unless otherwise shown on the plans, all timber used in the construction of permanent bridges, bridge fenders, bulkheads, and culverts shall be Southern Yellow Pine.

Southern Yellow Pine, Douglas Fir and Cypress, if required, shall meet the following requirements as to grading:

<i>Structural Purpose</i>	<i>Size of Member</i>	<i>Species</i>	<i>Standard Stress Grade</i>
Stringers, floorbeams, caps, mudsills, posts, fender timbers, bulkhead timbers, pier tops, ties, etc.	5" thickness and larger	Pine	1600 lb f Structural Beams and Stringers.
		Douglas Fir	1600 lb f Structural Beams and Stringers.
		Cypress	1400 lb f Structural Beams and Stringers.
Stringers, decking, bulkhead planks, sway bracing, felloe guards, pier bracing, nailing strips, bridging, fender and bulkhead timbers, handrails, handrail posts and culvert timbers.	4" thickness and smaller	Pine	1600 lb f Structural Joist and Plank.
		Douglas Fir	1600 lb f Structural Joist and Plank.
		Cypress	1400 lb f Structural Joist and Plank.

*f = Extreme fiber stress in bending in pounds per square inch for continuously dry locations.*

Southern Yellow Pine or Douglas Fir shall not be used in exposed structures except for handrails and handrail posts without preservative treatment.

(b) Temporary Structures: Temporary structures may be of any species and grade of timber which, in the opinion of the engineer, is satisfactory for this purpose.

**8.05 Grading of Structural Timber:**

(a) General Requirements: The following general provisions apply to all stress-grades: All material shall be well manufactured. All sizes prescribed in the specifications applying to lumber and timber refer to nominal sizes, and the American Standard rough and dressed sizes hereinafter enumerated shall be accepted as conforming thereto.

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All timber to be used without preservative treatment shall contain not less than 85 per cent heartwood on the girth, or on each face, side, or edge, measured at the point where the greatest amount of sapwood occurs.

For all timber to be pressure treated, there shall be no heartwood requirement, and the amount of sapwood shall not be limited.

Where wane is not desired, the specifications should state "Square Edge."

No piece of exceptionally light weight is permitted.

Only pieces consisting of sound wood, free from any form of decay are acceptable.

Slope of grain shall be measured over a distance sufficiently great to determine the general slope, disregarding slight local deviations. Within the middle half of the length of the piece the slope of grain shall not be steeper than specified.

Knot holes and holes from causes other than knots are measured and limited as provided for knots.

Cluster knots and knots in groups are not permitted.

(b) Knots in Joist and Plank: The size of a knot on a narrow face is taken as the width between lines enclosing the knot and parallel to the edges of the piece. The only knots measured on narrow faces, except spike knots which cross the corners of side-cut pieces, are those that do not show on wide faces.

The size of a knot on a wide face is the average of its largest and smallest diameters. A spike knot which crosses a corner of a side-cut piece and contains the intersection of the adjacent faces, or which extends entirely across a face of a piece, shall be measured only on its end or ends, between lines parallel to the edges of the piece.

The sizes of knots on narrow faces and at the edges of wide faces may increase proportionately from the size permitted in the middle third of the length to twice that size at the ends of the piece. The size of knots on wide faces may increase proportionately from the size permitted at the edge to the size permitted along the center line.

The sum of the sizes of all the knots within the middle half of the length of any face, measured as specified above for the face under consideration, shall not exceed four and one-half times the size of the largest knot allowed on that face.

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(c) Knots in Beams and Stringers: The size of a knot on a narrow face is taken as the width between lines enclosing the knot and parallel to the edges of the piece, except that when a knot on a narrow face extends into the adjacent one-fourth of the width of a wide face its least dimension is taken as its size.

The size of a knot on a wide face is its smallest diameter. Knots at the edges of wide faces are limited to the same size as on narrow faces but are measured according to this article.

The sizes of knots on narrow faces and at the edge of wide faces may increase proportionately from the size permitted in the middle third of the length to twice that size at the ends of the piece, except that the size of no knot shall exceed the size permitted along the center line of the wide face. The sizes of knots on wide faces may increase proportionately from the size permitted at the edge to the size permitted along the center line.

The sum of the sizes of all knots within the middle half of the length of any faces, measured as specified above for the face under consideration, shall not exceed four times the size of the largest knot allowed on that face.

(d) Shakes, Checks and Splits: Shakes, checks and splits, where permitted in the grade specified herein, are measured at the ends of the piece. Only those within the middle half of the height are considered. (Height equals the width of the wide face). The size of the shake is the distance between lines enclosing the shake and parallel to the wide faces of the piece. Permissible size is determined by the width of the narrow face of the piece.

Checks and splits are measured and limited in the same way as shakes. The following limitations apply to both ends, but only within the middle half of the height of the piece and within three times the height from the end. (Height equals the width of the wide face.) The size of the checks within this portion of the piece shall be taken as their estimated area, along the horizontal section showing the maximum area, divided by three times the height of the piece. (See note). When the checks on two parallel faces are opposite or approximately so, the sum of their sizes is taken. The sum of the sizes of shakes, checks and splits shall not exceed the permissible size of the shake.

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Note: A practical method of inspection in the field to determine the size of checks and splits under the above specification is as follows:

The size of checks within the specified portion of the piece shall be taken as the sum of seven depth measurements, one on the end and three on each side, divided by three. Each measurement shall represent the greatest depth of any check within the center half of the height; the measurement on the end shall be taken at the center of the width, and the three measurements on each side shall be taken at distances of 1, 2, and 3 times the height of the piece from the end in joist, plank, beams and stringers and the width of the piece from the end in posts and timbers. Each measurement shall be determined by the penetration into the piece of a probe 1/64 inch thick and 1/4 inch wide.

Checks extending entirely across the end within the middle half of the height shall not extend into the piece at the center of the width of the end a distance greater than the size of the allowable shake.

(e) Density, Douglas Fir: Dense Douglas Fir shall average on either one end or the other of each piece not less than six annual rings per inch in Douglas Fir, and, in addition, one-third or more summerwood (the dark portion of the annual ring), measured over 3 inches on a line at a right angle to the annual rings, located as described below. The contrast in color between summerwood and springwood shall be distinct.

Coarse-grained material excluded by this rule shall be accepted as dense if averaging one-half or more summerwood.

In boxed heart pieces, the line shall run from the pith to the corner farthest from the pith except, when the line is not representative, it shall be shifted sufficiently to present a fair average, but the distance from the pith to the beginning of the 3-inch portion of the line shall not be changed. When the least dimension is 6 inches or less, the 3-inch portion of the line shall begin at a distance of 1 inch from the pith. When the least dimension is more than 6 inches, the 3-inch portion of the line shall begin at a distance from the pith equal to one-fourth the least dimension of the piece.

In side-cut pieces (pith not present), the center of the 3-inch portion of the line shall be at the center of the end of the piece.

If a 3-inch portion of the line cannot be obtained, the



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measurement shall be made over as much of a 3-inch portion as is available.

In case of disagreement, two radial lines shall be chosen, and the summerwood and number of rings shall be taken as the average on these lines.

(f) Close Grain Douglas Fir: Close-grained Douglas Fir shall average on either one end or the other of each piece not less than six nor more than 20 annual rings per inch in Douglas Fir, measured over 3 inches on a line at right angles to the annual rings located as described below.

In boxed-heart pieces the line shall run from the pith to the corner farthest from the pith except, when the line is not representative, it shall be shifted sufficiently to present a fair average but the distance from the pith to the beginning of the 3-inch portion of the line shall not be changed. When the least dimension is 6 inches or less, the 3-inch portion of the line shall begin at a distance of 1 inch from the pith. When the least dimension is more than 6 inches, the 3-inch portion of the line shall begin at a distance from the pith equal to one-fourth the least dimension of the piece.

In side-cut pieces (pith not present), the center of the 3-inch portion of the line shall be at the center of the end of the piece.

If a 3-inch portion of the line cannot be obtained, the measurement shall be made over as much of a 3-inch portion as is available.

In case of disagreement, two radial lines shall be chosen and the number of rings shall be taken as the average on these lines.

Pieces of Douglas Fir averaging five rings or more than 20 shall be accepted if containing one-third or more summerwood.

(g) Density, Southern Yellow Pine: Dense longleaf or short-leaf yellow pine shall average on either one end or the other of each piece not less than six annual rings per inch, and, in addition, one-third or more summerwood, the darker, harder portion of the annual ring, measured over the third, fourth, and fifth inches of a radial line from the pith. The contrast in color between summerwood and springwood shall be sharp, and the summerwood shall be dark in color, except in pieces having considerably above the minimum requirement for summerwood.

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Coarse-grained material excluded by this rule shall be accepted as dense if averaging one-half or more summerwood.

The radial line shall be representative of the average growth of the cross section. In case of disagreement, two radial lines shall be chosen, and the number or rings per inch and percentage of summerwood shall be taken as the average determined on these lines.

In boxed heart pieces the measurement shall be made over the third, fourth and fifth inches from the pith along the radial line.

In material containing the pith, but not a 5-inch radial line, which is less than 2 by 8 inches in section or less than 8 inches in width, that does not show over 16 square inches on the cross section, the inspection shall apply to the second inch from the pith. In larger material that does not show a 5-inch radial line, the inspection shall apply to the 3 inches farthest from the pith.

In cases where timbers do not contain the pith and it is impossible to locate it with any degree of accuracy, the same inspection shall be made over 3 inches on an approximate radial line beginning at the edge nearest the pith in timbers over 3 inches in thickness and on the second inch nearest the pith in timbers 3 inches or less in thickness.

(h) Structural Joist and Plank with Load Applied to Either the Wide Face or the Narrow Face:

1. Standard Sizes:

Nominal thicknesses, 2 inches, 3 inches and 4 inches.  
Permissible minimum rough thicknesses in not to exceed 20 per cent of pieces in any one shipment:

2 inches .....  $\frac{1}{8}$  inch off  
3 inches and 4 inches .....  $\frac{3}{16}$  inch off  
Dressed thicknesses, S1S or S2S .....  $\frac{3}{8}$  inch off  
Nominal widths 4 inches and wider.

Permissible minimum rough widths in not to exceed 20 per cent of pieces in any one shipment:

4 inches and 6 inches .....  $\frac{3}{16}$  inch off  
8 inches and wider .....  $\frac{1}{4}$  inch off

Dressed widths, S1E or S2E:

4 inches and 6 inches .....  $\frac{3}{8}$  inch off  
8 inches and wider .....  $\frac{1}{2}$  inch off

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2. 1600 lb. f Structural Joist and Plank (Structural Square Edge and Sound): Dense longleaf southern pine. Dense shortleaf southern pine.

Slope of Grain.—1 in 12.

Knots.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Or At Edge of Wide Face, Middle Third of Length	At Center Line Of Wide Face	
		When Green	When Seasoned
2.....	3/4 in. } On	.....	.....
3.....	1 1/8 in. } Narrow	.....	.....
4.....	1 1/2 in. } Face	.....	.....
4.....	7/8 in. } At	1 1/2 in.	.....
6.....	1 1/4 in. } Edge	2 1/4 in.	.....
8.....	1 5/8 in. } of	3 in.	.....
10.....	2 1/8 in. } Wide	3 3/4 in.	.....
12.....	2 1/2 in. } Face	4 1/2 in.	.....
14.....	2 3/4 in. }	4 7/8 in.	.....
16.....	2 7/8 in. }	5 1/8 in.	.....
Width of Narrow Face			
When Green      When Seasoned			
Shakes, Checks, Splits:			
120 lb. Shear Grade.....		3/10	3/8
Wane.....		1/5 Width of any face	

3. 1600 lb. f Structural Joist and Plank: Close-grained Douglas Fir (Coast region).

Slope of Grain.—1 in 12.

Knots.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Or At Edge of Wide Face, Middle Third of Length	At Center Line Of Wide Face	
		When Green	When Seasoned
2.....	5/8 in. } On	.....	.....
3.....	1 in. } Narrow	.....	.....
4.....	1 1/4 in. } Face	.....	.....
4.....	3/4 in. } At	1 1/4 in.	.....
6.....	1 in. } Edge	1 7/8 in.	.....
8.....	1 1/8 in. } of	2 1/2 in.	.....
10.....	1 3/4 in. } Wide	3 1/4 in.	.....
12.....	2 1/8 in. } Face	3 7/8 in.	.....
14.....	2 1/4 in. }	4 1/8 in.	.....
16.....	2 1/2 in. }	4 1/2 in.	.....
Width of Narrow Face			
When Green      When Seasoned			
Shakes, Checks, Splits:			
100 lb. Shear Grade.....		1/6	1/4
Wane.....		1/6 Width of any face	

DIVISION II—PART 4

4. 1400 lb. f Structural Joist and Plank: Tidewater red cypress.

Slope of Grain.—1 in 14.

Knots and Peck.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Or At Edge of Wide Face, Middle Third of Length		At Center Line Of Wide Face
2.....	5/8 in.	} On Narrow Face	.....
3.....	7/8 in.		.....
4.....	1 1/8 in.		.....
4.....	5/8 in.	} At Edge of Wide Face	1 1/8 in.
6.....	1 in.		1 3/4 in.
8.....	1 1/4 in.		2 3/8 in.
10.....	1 5/8 in.		2 7/8 in.
12.....	1 7/8 in.		3 1/2 in.
14.....	2 in.		3 3/4 in.
16.....	2 1/4 in.		4 1/8 in.

Shakes, Checks, Splits:	Width of Narrow Face	
	When Green	When Seasoned
120 lb. Shear Grade.....	1/10	1/5
Wane.....	1/6	Width of any face

(i) Structural Beams and Stringers with Load Applied to the Narrow Face:

1. Standard Sizes:

Nominal thickness 5 inches and thicker.

Permissible minimum rough thicknesses in not to exceed 20 per cent of pieces in any one shipment:

5-inch and 6-inch ..... 3/16 inch off

8-inch and wider ..... 1/4 inch off

Dressed thicknesses, S1S or S2S..... 1/2 inch off

Nominal Widths, 8 inches and wider.

Permissible minimum rough widths in not

to exceed 20 per cent of pieces in any one

shipment ..... 1/4 inch off

Dressed widths, S1E or S2E..... 1/2 inch off

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2. 1600 lb. f Structural Beams and Stringers (Structural Square Edge and Sound): Dense longleaf southern pine. Dense shortleaf southern pine.

Slope of Grain.—1 in 12.

Knots.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Middle Third Of Length		At Center Line Of Wide Face
	When Green	When Seasoned	
5.....	1½ in.	.....	.....
6.....	1⅞ in.	.....	.....
8.....	2¼ in.	.....	2½ in.
10.....	2⅝ in.	.....	3⅛ in.
12.....	2⅞ in.	.....	3¼ in.
14.....	2⅞ in.	.....	4 in.
16.....	3 in.	.....	4⅜ in.
18.....	.....	.....	4⅝ in.
20.....	.....	.....	4⅞ in.

Shakes, Checks, Splits:	Width of Narrow Face	
	When Green	When Seasoned
120 lb. Shear Grade.....	3/10	3/8
Wane.....	1/6 Width of any face	

3. 1600 lb. f Structural Beams and Stringers: Close-grained Douglas Fir (Coast Region).

Slope of Grain.—1 in 15.

Knots.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Middle Third Of Length		At Center Line Of Wide Face
	When Green	When Seasoned	
5.....	1⅞ in.	.....	.....
6.....	1⅞ in.	.....	.....
8.....	1⅞ in.	.....	1⅞ in.
10.....	1¾ in.	.....	2¼ in.
12.....	1⅞ in.	.....	2⅝ in.
14.....	2⅞ in.	.....	2⅞ in.
16.....	2¼ in.	.....	3⅛ in.
18.....	.....	.....	3⅝ in.
20.....	.....	.....	3½ in.

Shakes, Checks, Splits:	Width of Narrow Face	
	When Green	When Seasoned
100 lb. Shear Grade.....	1/6	1/4
Wane.....	1/6 Width of any face	

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4. 1400 lb. f Structural Beams and Stringers: Tidewater red cypress.  
 Slope of Grain.—1 in 16.  
 Knots and Peck.—Maximum permissible size in inches:

Nominal Width of Face, In.	On Narrow Face, Middle Third Of Length	
	When Green	When Seasoned
5.....	1 in.	.....
6.....	1 1/8 in.	.....
8.....	1 3/8 in.	1 1/2 in.
10.....	1 1/2 in.	1 7/8 in.
12.....	1 5/8 in.	2 1/4 in.
14.....	1 3/4 in.	2 1/2 in.
16.....	1 7/8 in.	2 5/8 in.
18.....	.....	2 7/8 in.
20.....	.....	3 in.

Shakes, Checks, Splits:	Width of Narrow Face	
	When Green	When Seasoned
120 lb. Shear Grade.....	1/10	1/5
Wane.....	1/8 Width of any face	

CONSTRUCTION METHODS

8.06 Storage:

Lumber and timber on the site of the work shall be stored in piles. 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 with a 2-inch layer of earth. The ground underneath and in the vicinity of all material piles shall be cleared of weeds and rubbish.

8.07 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."

8.08 Handling:

The timbers shall be handled carefully without sudden dropping, breaking of outer fibres, bruising or penetrating the

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surface with tools. It shall be handled with rope slings. Cant-dogs, peaveys, hooks or pike-poles shall not be used.

### 8.09 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.

### 8.10 Cuts and Abrasions:

All cuts in treated timbers, and all abrasions after having been carefully trimmed, shall be coated with two applications of a mixture of 60 per cent creosote oil and 40 per cent roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

### 8.11 Treating Bolt Holes:

Before driving bolts, all holes bored after treatment shall be impregnated with hot creosote oil by means of an approved bolt hole treater. Any unfilled holes, after being treated with creosote oil shall be plugged with creosoted plugs.

### 8.12 Untreated Timber:

In structures of untreated timber, the following surfaces shall be coated thoroughly with two 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. Where heart cypress is used, this treatment will not be required.

## MEASUREMENT AND PAYMENT

### 8.13 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 standard sizes. The standard size dimensions shall be used in the computations even though the actual size be scant in the amount provided above. The measurement of timber will include only such timber as is a part of

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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.

### 8.14 Basis of Payment:

The quantities measured as provided above, shall be paid for at the contract unit prices per thousand feet board measure for "Untreated Timber," or "Creosoted Timber," as the case may be, which prices and payments 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, Creosoted Timber, per thousand feet board measure.

## SECTION 9 CULVERT PIPE SEWER PIPE

### 9.01 Description:

This item shall consist of furnishing sections of cast iron, corrugated metal, concrete, or vitrified clay pipe, of the diameter 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.

### MATERIALS

### 9.02 Reinforced Concrete Pipe:

Material Covered: These specifications cover reinforced concrete pipe intended for use in the construction of pipe culverts and pipe storm sewers. Unless otherwise specified in the special provisions standard strength pipe shall be furnished.

(a) Reinforced Concrete: The reinforced concrete shall consist of Portland cement, mineral aggregate and water, in



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which steel has been embedded in such a manner that the steel and concrete act together.

(b) Cement: Portland cement shall conform to the requirements of Article 5.03, Part 4, Division II or Standard Specifications for High-Early-Strength Portland cement Article 5.04, Part 4, Division II.

(c) Steel: Reinforcement may consist of either wire which conforms to the requirements for cold-drawn steel wire for concrete reinforcement, or of bars of structural or intermediate grade which conform to the requirements of billet steel concrete reinforcement bars, structural or intermediate grade, Section 6, Part 4, Division II. Specific reference is made to Articles 6.02 and 6.04.

(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 matter 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.

(f) Placing Reinforcement: In pipe having one line of reinforcement, the reinforcement shall be placed equally distant from the inner and outer surfaces of the pipe. In pipe having two lines of reinforcement, each line shall be placed so that the net protective covering of concrete over the reinforcement shall be one inch.

(g) Minimum Designs: The ultimate load, as determined by the Three-Edge-Bearing Method or the Sand-Bearing Method, shall be not less than the ultimate load specified in Tables I and II. When the test load reaches the cracking load given in tables for the size and class of pipe tested, there shall be in the barrel of the pipe no cracks having a width of 0.01 inch or more for a length of 1 foot or more. The cracks shall be considered 0.01 inch in width when the point of measuring gage will, without force, penetrate it 1/16 inch at close intervals throughout the specified distance of 1 foot. The width of crack shall be measured by means of a gage made from

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a leaf 0.01 inch in thickness (as in a set of standard machinists gages), ground to a point 1/16 inch in width with corners rounded, and a taper of 1/4 inch per inch. The ultimate load is reached when the pipe will sustain no greater load.

The absorption, as determined by the Absorption Test, shall not exceed 8 per cent of the dry weight. Pipe shall be considered as conforming to these specifications for absorption when not less than 80 per cent of the number of specimens tested, including any retested, conform to the test requirements. When the initial absorption specimen from a pipe fails to conform to these specifications, the absorption test shall be made on another specimen from the same pipe and the results of the retest shall be substituted for the original test results.

The shell thickness and amount of circumferential reinforcement shall not be less than given in Tables I and II for the classes and sizes of pipe therein specified.

TABLE 1—STANDARD-STRENGTH REINFORCED-CONCRETE CULVERT PIPE

Internal Diameter of Pipe, In.	Concrete, 3500 lb. per sq. in.		Concrete, 4500 lb. per sq. in.		Strength Test Requirements, lb. per linear ft. of pipe	
	Minimum Shell Thickness, In.	Minimum Reinforcement, sq. in. per linear ft. of pipe barrel	Minimum Shell Thickness, In.	Minimum Reinforcement, sq. in. per linear ft. of pipe barrel	Three-Edge Bearing	
		Circular Reinforcement in Circular Pipe		Circular Reinforcement in Circular Pipe	Load to Produce a 0.01-in. Crack	Ultimate Load
12.....	2	1 line 0.07	1 3/4	1 line 0.08	2,250	3,500
15.....	2 1/4	1 line 0.09	2	1 line 0.11	2,625	4,065
18.....	2 1/2	1 line 0.12	2 1/4	1 line 0.14	3,000	4,500
24.....	3	1 line 0.17	2 1/2	1 line 0.20	3,000	5,000
30.....	3 1/2	2 lines, each 0.17	3	1 line 0.28	3,375	5,750
36.....	4	2 lines, each 0.18	3 3/8	2 lines, each 0.22	4,050	6,600
42.....	4 1/2	2 lines, each 0.21	3 3/4	2 lines, each 0.25	4,725	7,350
48.....	5	2 lines, each 0.25	4 1/4	2 lines, each 0.31	5,400	8,000
54.....	5 1/2	2 lines, each 0.30	4 5/8	2 lines, each 0.37	5,850	9,000
60.....	6	2 lines, each 0.33	5	2 lines, each 0.41	6,000	10,000
72.....	7	2 lines, each 0.40	6	2 lines, each 0.48	6,600	12,000
84.....	8	2 lines, each 0.46	7	2 lines, each 0.54	7,000	14,000

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The acceptability of pipe shall be determined by the results of the strength and absorption tests specified herein and by inspection to determine whether the pipe conforms to the specifications in design and freedom from defects.

TABLE II—EXTRA-STRENGTH REINFORCED-CONCRETE CULVERT PIPE

Internal Diameter of Pipe, In.	Concrete, 4500 lb. per sq. in.		Strength Test Requirements, lb. per linear ft. of pipe	
	Minimum Shell Thickness, in.	Minimum Reinforcement, sq. in. per linear ft. of pipe barrel	Three-Edge Bearing	
		Circular Reinforcement in Circular Pipe	Load to Produce a 0.01-in Crack	Ultimate Load
24.....	3	1 line 0.26	4,000	6,000
30.....	3½	2 lines, each 0.24	5,000	7,500
36.....	4	2 lines, each 0.28	6,000	9,000
42.....	4½	2 lines, each 0.33	7,000	10,500
48.....	5	2 lines, each 0.38	8,000	12,000
54.....	5½	2 lines, each 0.44	9,000	13,500
60.....	6	2 lines, each 0.50	9,000	15,000
72.....	7	2 lines, each 0.60	9,900	18,000
84.....	8	2 lines, each 0.72	10,500	21,000

(h) Joints: The ends of the pipe shall be of such design that the pipe when laid shall form a continuous conduit with a smooth and uniform interior surface.

(i) Longitudinals: Each line of circumferential reinforcement shall be assembled into a cage which shall contain sufficient longitudinal bars or members, extending through the barrel of the pipe; to maintain the reinforcement rigidly in exact shape and correct position within the form.

(j) Laps, Welds, and Spacing: If the splices are not welded, the reinforcement shall be lapped not less than 30 diameters for bars, and 40 diameters for cold-drawn wire. If welded, the member at either a welded splice or intersection shall develop a tensile strength not less than the minimum strength required for the reinforcement by the applicable specifications cited in Paragraph (c). The spacing center to center of ad-

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jacent rings of circumferential reinforcement in a cage shall not exceed 4 inches for pipe up to and including 48 inches in diameter, and shall not exceed the shell thickness for larger pipe, and shall in no case exceed 6 inches.

(k) Joint Reinforcement: The joint shall have a circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

(l) Curing: The pipe shall be properly cured by any approved method.

(m) Testing: All physical tests shall be made in accordance with the requirements of A. S. T. M. Designation C 76-37 and the contractor will be required to furnish the specified number of pipe for the purpose of tests without charge.

(n) General: Size and Permissible Variations, Workmanship and Finish Marking, and Inspection and Rejection shall all comply with the requirements of A. S. T. M. Designation C 76-37.

### 9.03 Corrugated Metal Pipe Culverts:

(a) Material Covered: These specifications cover corrugated metal pipe for use in the construction of pipe culverts.

(b) Requirements: Corrugated metal pipe shall conform to the requirements of the A. A. S. H. O., Standard Specifications for Corrugated Metal Pipe, Specification M-36.

(c) Sampling and Testing: Sampling and testing shall be done in accordance with the A.A.S.H.O. Specification M-36.

### 9.04 Cast-Iron Culvert Pipe:

(a) Material Covered: These specifications cover cast iron pipe for use in the construction of pipe culverts. Unless otherwise specified in the special provisions, standard strength pipe shall be furnished.

(b) Requirements: Cast iron pipe shall conform to the requirements of the A. S. T. M. Tentative Standard Specifications for Cast Iron Culvert Pipe, Serial Designation A 142-35 T.

(c) Sampling and Testing: Sampling and testing of cast iron culvert pipe shall be done in accordance with methods prescribed in the A.S.T.M. Tentative Standard Specifications for Cast Iron Culvert Pipe, Serial Designation A 142-35 T.

### 9.05 Clay Sewer Pipe:

(a) Material Covered: These specifications cover clay sewer pipe for use in construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

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(b) Requirements: Clay sewer pipe shall conform to the requirements of the A. S. T. M. Standard Specifications for clay sewer pipe, Serial Designation C 13-35.

(c) Sampling and Testing: Sampling and testing of clay sewer pipe shall be done in accordance with methods prescribed in the A. S. T. M. Standard Specifications for Clay Sewer Pipe, Serial Designation C 13-35.

### 9.06 Concrete Sewer Pipe:

(a) Material Covered: These specifications cover concrete sewer pipe for use in construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

(b) Requirements: Concrete sewer pipe shall conform to the requirements of the A. S. T. M. Standard Specifications for Concrete Sewer Pipe, Serial Designation C 14-35.

(c) Sampling and Testing: Sampling and testing of concrete sewer pipe shall be done in accordance with methods prescribed in the A. S. T. M. Standard Specifications for Concrete Sewer Pipe, Serial Designation C 14-35.

### 9.07 Reinforced Concrete Sewer Pipe:

(a) Material Covered: These specifications cover reinforced concrete sewer pipe for use in construction of sewers, when the use of this material is specified. This material shall not be used for culvert pipe.

(b) Requirements: Reinforced concrete sewer pipe shall conform to the requirements of the A. S. T. M. Standard Specifications for Reinforced Concrete Sewer Pipe, Serial Designation C 75-35 except that elliptical pipe and elliptical reinforcement will not be permitted.

(c) Sampling and Testing: Sampling and testing Reinforced Concrete Sewer Pipe shall be done in accordance with methods prescribed in A. S. T. M. Standard Specifications for Reinforced Concrete Sewer Pipe, Serial Designation C 75-35.

## CONSTRUCTION METHODS

### 9.08 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 twelve inches except in unstable material.

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The pipe shall be bedded in an earth foundation of uniform density carefully shaped, by means of a template supported at the desired grade, to fit the lower part of the pipe exterior for at least ten 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 one-half inch per foot height of fill over the top of the pipe, with a minimum allowable thickness of eight 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."

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.

### 9.09 Laying Pipe:

The pipe shall be carefully laid true to lines and grades given. 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, two 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 two sections are flush. The remainder of the joint shall be solidly filled with mortar and neatly troweled and finished to a forty-five 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, two parts sand, one-tenth 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

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the initial set, mortar on the outside of joints shall be protected from the elements with earth or other covering.

Corrugated metal pipe 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.

The interior of culvert and sewer pipe shall be cleared 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.

Branch openings or service connections provided for future extension shall be plugged as directed by the engineer.

Any pipe which is not true in alignment or which shows settlement after laying, shall be taken up and relaid at the contractor's expense.

### 9.10 Backfilling:

Selected embankment material, free from large lumps, clods, or rock shall be placed alongside the pipe in layers not exceeding six 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 mechanical rammers or by hand tamping with heavy iron tampers having a tamping face not exceeding twenty-five square inches in area, 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.

### 9.11 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

### 9.12 Method of Measurement:

Culvert and sewer pipe will be measured by the linear foot. The length of measurement shall be the actual length of pipe placed and accepted. Excavation for removal of existing pipe

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culverts will be measured as provided under Article 4.14, Part 1, Division II.

**9.13 Basis of Payment:**

Pipe placed and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot for "Culvert Pipe" and "Sewer Pipe," which price and payment shall constitute full compensation for furnishing, hauling, and installing the pipe; for all excavation, except as provided under Article 9.12, preparation of bed and backfilling; and for the 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 for pipe 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.



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- 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 4-9-38, Twelve Inch Cast Iron Culvert Pipe, (Standard Pipe), per linear foot.

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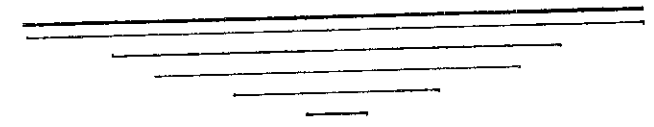
- Item 4-9-39, Fourteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-40, Sixteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-41, Eighteen Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-42, Twenty Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-43, Twenty-four Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-44, Thirty Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-45, Thirty-six Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-46, Forty-two Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-47, Forty-eight Inch Cast Iron Culvert Pipe (Standard Pipe), per linear foot.
- Item 4-9-48, Twelve Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-49, Fourteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-50, Sixteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-51, Eighteen Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-52, Twenty Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-53, Twenty-four Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-54, Thirty Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-55, Thirty-six Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-56, Forty-two Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-57, Forty-eight Inch Cast Iron Culvert Pipe (Heavy Pipe), per linear foot.
- Item 4-9-58, Four Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-59, Six Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-60, Eight Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-61, Ten Inch Clay Sewer Pipe, per linear foot.

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- Item 4-9-62, Twelve Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-63, Fifteen Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-64, Eighteen Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-65, Twenty-one Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-66, Twenty-four Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-67, Twenty-seven Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-68, Thirty Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-69, Thirty-three Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-70, Thirty-six Inch Clay Sewer Pipe, per linear foot.
- Item 4-9-71, Four Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-72, Six Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-73, Eight Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-74, Ten Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-75, Twelve Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-76, Fifteen Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-77, Eighteen Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-78, Twenty-one Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-79, Twenty-four Inch Concrete Sewer Pipe, per linear foot.
- Item 4-9-80, Twenty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-81, Twenty-seven Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-82, Thirty Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-83, Thirty-three Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-84, Thirty-six Inch Reinforced Concrete Sewer Pipe, per linear foot.

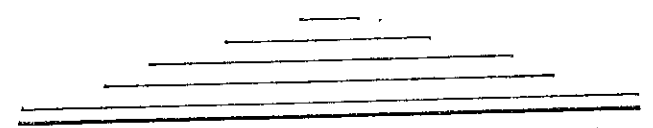
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- Item 4-9-85, Forty-two Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-86, Forty-eight Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-87, Fifty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-88, Sixty Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-89, Sixty-six Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-90, Seventy-two Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-91, Seventy-eight Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-92, Eighty-four Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-93, Ninety Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-94, Ninety-six Inch Reinforced Concrete Sewer Pipe, per linear foot.
- Item 4-9-95, One Hundred Eight Inch Reinforced Concrete Sewer Pipe, per linear foot.



## **DIVISION II**

### **Part 5—Roadside Improvement**



DIVISION II—PART 5

**SECTION 1**

**SURFACE DRESSING**

**1.01 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 in accordance with the plans and these specifications.

**CONSTRUCTION METHODS**

**1.02 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.

**1.03 Machine Method:**

All hard pan areas, where practicable and necessary, shall be plowed, disced, cross-disced, 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 three inches, it will not be necessary to plow same when discing 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 obstructions occur, the contractor will be required to disc same by hand methods if discing 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 clod which cannot be broken up easily and any other material or debris which are detrimental to a smooth or well prepared surface shall be removed from the project and satisfactorily disposed of as directed by the engineer.

**1.04 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

## DIVISION II—PART 5

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 1.03.

### MEASUREMENT AND PAYMENT

#### 1.05 Method of Measurement:

Measurement of surface dressing will be measured 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.

#### 1.06 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 5-1-1, Surface Dressing (Machine Method), per square yard.

Item 5-1-2, Surface Dressing (Machine Method), per acre.

Item 5-1-3, Surface Dressing (Hand Method), per square yard.

## SECTION 2

### TREE SURGERY

#### 2.01 Description:

This item shall consist of repairing rotten spots in trunks and limbs of trees in accordance with the plans and these specifications or as directed by the engineer.

### CONSTRUCTION METHODS

#### 2.02 Tree Surgeons:

All tree surgery shall be performed by tree surgeons who are certified and licensed by the Louisiana Horticultural Board.

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### 2.03 Preparation of Cavity:

All rotten, stained, discolored, water soaked, diseased and insect eaten wood shall be removed from the particular part of the tree being repaired. This excavation must continue until sound live wood is reached. The cavity shall not be made any larger than is necessary to perform the excavation and the final shaping of same shall be made pointed at the top and bottom in the direction of the general growth and the lower part of the back of the cavity shall be cut, where practical, so that good drainage will result.

Care must be taken in working around the cambium. All cutting tools must be sharp. The final cutting along the edges of the bark and cambium must be followed immediately by a coating of shellac, which must thoroughly cover the cambium and a narrow strip of the sapwood and bark. The shellac must be applied within three to five minutes after the final cutting of the cambium. Upon completion of this operation, and after the engineer has approved the cavity, it shall be sterilized by the application of a coating of creosote or other sterilizing agent. When the sterilizing agent is dry, a waterproofing coat of tar, or other bituminous material approved by the engineer, shall be applied over all surface areas which have been creosoted and shellacked.

After all sterilizing and waterproofing materials are dry, small cavities shall be wired with nails and crisscrossed wires. Where large cavities occur, they shall be bolted and braced with iron rods when directed by the engineer. In placing bolts through trunks, limbs or branches, all bolt heads and nuts shall be countersunk just below the level of the cambium. The cuts made for countersinking shall be sterilized and waterproofed before inserting the bolts.

### 2.04 Placing Cement Mortar:

The cavity shall then be filled with Portland cement mortar. The mortar shall be composed of one part cement, two parts clean sand, and one-fourth part powdered asbestos with sufficient lamp black added to darken the mixture to a gray color. Sufficient water shall be added to provide proper consistency. The mortar shall be thoroughly tamped into the cavity, expansion joints formed as hereinafter provided, and the outside surface of the mortar smoothed to present a neat appearance. At the edge of the cavity, the mortar shall be cut or smoothed so that the surface of same will be just under the level of the cambium layer. The whole surface of the filling



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shall be covered with at least two layers of six to seven ounce burlap or the equivalent which shall be kept wet for at least twenty-four hours.

All expansion joints shall be formed of tar paper, building paper, or other material approved by the engineer. Expansion joints, in cavities over two feet long, shall be placed not over ten inches apart. Expansion joints, in cavities less than two feet long and over six inches long, shall be placed from six to eight inches apart. Expansion joints will not be required in cavities less than six inches long unless specifically directed by the engineer.

### MEASUREMENT AND PAYMENT

#### 2.05 Method of Measurement:

Tree surgery will be measured by the tree and the number of trees repaired by tree surgery shall be counted.

#### 2.06 Basis of Payment:

The number of trees completed and accepted, measured as provided above, shall be paid for at the contract unit price per tree for "Tree Surgery," 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 5-2-1, Tree Surgery, per tree.

## SECTION 3

### FERTILIZER

#### 3.01 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

#### 3.02 Fertilizer:

The amount and kind of fertilizer to be used will be shown on the plans or special provisions. 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.

## DIVISION II—PART 5

### CONSTRUCTION METHODS

#### 3.03 Fertilizing Broadcast:

Fertilizer shall be uniformly broadcast over the area to be fertilized either by hand or machine methods.

When fertilizer is applied following surface dressing, it shall be thoroughly incorporated in the soil by light discing or harrowing. Fertilizer may be applied just before final discing 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.

#### 3.04 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 shown on the plans and as directed by the engineer. Where required, the area fertilized shall be thoroughly watered.

#### 3.05 Fertilizing Existing Trees:

A circle of holes three to four 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 three to four 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 twelve to eighteen inches deep and approximately two and one-half to three 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

#### 3.06 Method of Measurement:

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

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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 1.

### 3.07 Basis of Payment:

The number of units of fertilizer placed and accepted, measured as provided above, shall be paid for at the contract 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 5-3-1, Fertilizing Broadcast, (Commercial Fertilizer) per pound.
- Item 5-3-2, Fertilizing Broadcast, (Domestic Fertilizer) per cubic yard.
- Item 5-3-3, Fertilizing Sodding, (Commercial Fertilizer) per pound.
- Item 5-3-4, Fertilizing Sodding, (Domestic Fertilizer) per cubic yard.
- Item 5-3-5, Fertilizing Existing Trees, (Commercial Fertilizer) per pound.
- Item 5-3-6, Fertilizing Existing Trees, (Domestic Fertilizer) per cubic yard.

## SECTION 4

### PRUNING EXISTING TREES

#### 4.01 Description:

This item shall consist of shaping existing trees and removing rotten limbs, branches or any other parts of the tree designated by the engineer in accordance with the plans and these specifications.

### CONSTRUCTION METHODS

#### 4.02 Pruning:

All pruning work shall be done by or under the supervision of a competent and expert pruner.

All rotten stubs which remain from previous pruning or damage; all dead branches and limbs; all broken or badly scarred branches and limbs; all crossing branches particularly where rubbing of the bark is evident and any other limbs

## DIVISION II—PART 5

and branches designated by the engineer shall be removed. The natural shape of the tree shall not be changed by "topping" or any other unnatural pruning methods.

Limbs of over one inch caliper shall be cut not less than one and one-half feet away from the trunk or base limb by making an undercut and then making a downward cut just over and forward of the undercut so that the limb will break and fall without injury to the trunk or base limb. The stub remaining shall then be cut off at its base. No stubs, regardless of size, shall be left.

The cut surface of branches of one inch caliper and over shall be painted with a mixture of one-fourth creosote and three-fourths tar by volume or other approved material. The application must thoroughly cover all portions of the cut.

### MEASUREMENT AND PAYMENT

#### 4.03 Method of Measurement:

Pruning of existing trees will be measured by the tree and all trees actually pruned shall be counted.

#### 4.04 Basis of Payment:

The number of trees pruned and accepted, measured as provided above, shall be paid for at the contract unit price per tree for "Pruning Existing Trees," 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 5-4-1, Pruning Existing Trees, per tree.

## SECTION 5

### SELECTIVE THINNING

#### 5.01 Description:

This item shall consist of the clearing and grubbing of designated existing native trees from within the areas designated on the plans.

### CONSTRUCTION METHODS

#### 5.02 General:

All trees, except those designated by the engineer to remain standing, shall be cleared and grubbed in accordance with Articles 1.02 and 2.02, Part 1, Division II.

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### MEASUREMENT AND PAYMENT

#### 5.03 Method of Measurement:

Selective thinning will be measured by the lump and the entire area cleared and grubbed will be included.

#### 5.04 Basis of Payment:

The areas cleared and grubbed, measured as provided above, shall be paid for at the contract price per lump, for "Selective Thinning," 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 5-5-1, Selective Thinning, per lump.

## SECTION 6

### PLANTING TREES, SHRUBS, VINES AND OTHER PLANTS

#### 6.01 Description:

This item shall consist of furnishing and planting the various types and sizes of plants shown on the plans and in the Planting List and Summary Plant List of the special provisions in accordance with the plans and these specifications.

The plans and special provisions are prepared with a KEY NUMBER SYSTEM with a detailed planting list accompanying, showing the location of plants. These locations are approximate and may be adjusted or changed to suit actual field conditions at the discretion of the engineer. The Planting List and Summary Plant List are included in the special provisions.

#### MATERIALS

#### 6.02 State and Federal Regulations:

Plant material shall be free from injurious insect pests and plant diseases and subject to all regulations of the Federal and State Departments of Agriculture. The contractor shall obtain the proper certificates for the movement of nursery stock, intra-state or inter-state, and shall comply with all other requirements before and during movement or shipment of plants.

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### 6.03 Adopted Standards for Nursery Stock:

Plant material shall conform in size and grade with the "Standard Rules and Tables for Growing and Grading Ornamental and Fruit Nursey Stock," of the American Association of Nurserymen, insofar as applicable hereto, and as further specified in the itemized Summary Plant List in the special provisions. Each plant must be true to name and legibly tagged with the name and size of the material according to general standards of nursery practice, except in the case where many plants of the same kind, as small vines or small shrubs are furnished in quantity lots and which are easily distinguishable. In such cases the containers or a few plants in the lot must be marked.

### 6.04 Source of Plant Material:

All plant material shall be nursery grown unless written permission is obtained from the engineer to use selected native stock which permission will be granted only in case the contractor demonstrates that it is impracticable to obtain nursery grown plant material or if in the opinion of the engineer selected native stock will be better suited or superior in quality to that obtained from a nursery.

If permission is given to use selected native stock, the engineer will inspect the materials before digging and the contractor shall tag or label each plant so selected and dig the plants as directed. In the event any selected plant does not show a sufficient root system after being dug, it will be rejected. The handling, care, and other requirements of collected plants will be the same as that described for nursery grown stock.

### 6.05 Grades and Sizes:

All plants shall be a first class representative of its normal species and shall grade XX (extra heavy) unless otherwise specified. Trees shall have average and normal well developed branch systems together with vigorous root systems according to the species and grade.

All trees shall have reasonably straight trunks. Deciduous trees which normally produce "leaders," such as sycamores, willow oaks, water oaks and elms, must have "leaders" and they shall not be removed or cut back. Evergreen trees, such as live oaks and magnolias, will be acceptable without strict "leaders," providing the branching system of each conforms to or represents the natural growth and provided further that they do not show unnatural growth caused by severe pruning or cutting back.

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The sizes of plants shown on the Summary Plant List in the special provisions are the minimum acceptable sizes. If the contractor desires to furnish material which is oversize he shall obtain permission from the engineer and the handling, care, and planting of such oversize stock shall be as directed.

**6.06 Substitutions:**

No substitutions of plant material shall be made without the written permission of the engineer and then only when sufficient evidence has been presented by the contractor that the plant cannot be obtained. Permission will be given to substitute only such plants as are equal to or better than the original plant.

**6.07 Balled and Burlapped Plants:**

Plants designated "B" in the planting list and summary plant list shall be carefully dug with balls of dirt sufficiently large to include enough roots at the sides and the bottom of the plant to insure proper growth. These balls shall be dug by "cutting" in a workmanlike manner and not by "spading out" or "lifting" from the ground. The burlap must be securely fastened around the ball by an approved method such as pinning with nails or tying with cord. Large balls one and one-half feet or more in diameter shall be tied with small rope to insure against settling or cracking. Balled plants must be handled only by the balls of dirt.

Where balled and burlapped plants are called for, the contractor shall ascertain from the engineer the sizes of the balls of dirt to be dug with each variety of plant. The following diameter of balls with relation to the height or caliper will apply:

Small Trees, Shrubs and Vines		
	Height	Minimum Diameter of Ball
1	inch to 1½ inches	10 inches
1½	inches to 1¾ inches	12 inches
1¾	inches to 2 inches	15 inches
2	inches to 2½ inches	16 inches
2½	inches to 3 inches	18 inches
Large Trees—Evergreen		
	Caliper	Minimum Diameter of Ball
1	inch to 1½ inches	18 inches
1½	inches to 1¾ inches	20 inches
1¾	inches to 2 inches	24 inches
2	inches to 2½ inches	20 inches
2½	inches to 3 inches	33 inches

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The depth of balls of dirt shall be determined by the root showing as digging progresses, but in no case will plants be accepted which have flat, shallow balls of dirt when such plants are known to have deep root systems. Extreme care must be used in digging large trees such as magnolia and live oak.

### 6.08 Bare Rooted Plants:

Plants designated "A" in the planting list and summary plant list shall be furnished with roots bare. They must be dug with sufficient root systems to insure their growth and the roots shall not be exposed to wind or sun during digging. Small shrubs dug bare rooted shall be taken up with a majority of roots intact but large deciduous trees may have some of their roots removed. The following table shows the minimum acceptable sizes of root systems which will govern the digging of large deciduous trees.

Caliper	Minimum Diameter of Root System
1 inch to 1½ inches	24 inches
1½ inches to 2 inches	30 inches
2 inches to 2½ inches	33 inches
2½ inches to 3 inches	36 inches
3 inches to 4 inches	48 inches

### 6.09 Notification by Contractor:

As soon as the contractor has determined where the different plant materials will be obtained he shall notify the engineer. The engineer may inspect any or all plant material at the point of origin before same has been dug and prepared for shipment. If the material selected by the contractor is not suitable as to grade, type, size, or in any other manner does not conform to the specifications or special provisions, same will be rejected.

### 6.10 Notification of Delivery:

The contractor shall give the engineer at least twenty-four hours notice before making any delivery of plant material to the project. Each shipment shall be accompanied by an invoice showing the sizes and varieties of plants included.

### 6.11 Receipt of Nursery Stock:

On delivery of the nursery stock, the contractor shall assist the engineer in the inspection of the plant material. No plant shall be planted until it shall have been inspected and accepted by the engineer.



## DIVISION II—PART 5

Freshly dug stock shall be used. Plants showing signs of storage damage will be rejected. All precautions that are customary in good trade practice shall be taken to insure the arrival of all plants at the project in good condition for successful growth.

### 6.12 Rejection of Plant Material:

All plants which do not strictly comply with these specifications and special provisions will be rejected.

Any plant having any of the following unnatural or objectionable features shall be rejected. Excessive abrasions of the bark; dried out root system; excessive dead wood; dried up wood; excessive sunscald injuries; undeveloped and weak top or roots or both; crooked or one-sided development of tops; no straight leaders on trees naturally and normally having them; broken or removed leaders; untrue types or sizes; not complying with Federal and State laws or regulations bearing on inspections and certificates; excessively damaged balls of dirt; balls of dirt dug from loose soil which could not be expected to properly ball and hold in handling; and plants actually dead.

The rejected material shall be replaced as quickly as possible with other material meeting the requirements and at the expense of the contractor.

## CONSTRUCTION METHODS

### 6.13 Seasonal Operations:

All planting operations shall be performed in the proper season. In general, the planting of balled and burlapped plants shall not begin before November first in any portion of the State and planting shall cease by April first in the southern half of the State and by April fifteenth in the northern half. The planting of bare rooted plants shall not begin before November fifteenth in any portion of the State and shall cease by March tenth in the southern half of the State and by March twentieth in the northern half.

However, due to varying weather conditions, the kind of plants and the origin of plants, the above dates may be varied when directed by the engineer. In the event that the planting season expires before the completion of the contract, the Commission reserves the right to suspend the contract until the next planting season. If the contract is suspended, the engineer will accept the completed portion of the contract and

## DIVISION II—PART 5

relieve the contractor from all responsibility in connection therewith.

### **6.14 Care and Handling of Plants Before and During Planting:**

The contractor shall in loading, unloading, or handling plants exercise the utmost care to prevent injuries to trunks, limbs, branches and roots. Immediately following delivery and inspection at the site of the work, all plants must be cared for in an approved horticultural manner satisfactory to the engineer. Plants must not be allowed to dry out.

If not immediately planted, balled plants must be adequately protected by covering the balls of dirt with soil, hay or straw and shall be watered at frequent intervals. The solidity of the balled plants shall be carefully preserved. They must not be handled by their tops in lifting, moving or setting, but must be handled at all times by their balls of dirt.

All bare rooted plants must be "heeled in" immediately in moist soil, watered and otherwise cared for in a satisfactory manner as soon as they are received and inspected, unless they are immediately planted. Bare rooted plants shall be puddled if directed. While bare rooted plants are being transported to and from "heeled in" beds, are being distributed, or awaiting planting after distribution, they shall be protected from drying out by means of wet canvas, burlap, straw, hay, puddling or as directed.

### **6.15 Pruning:**

Pruning must be done as soon as possible after the arrival of the plants and shall conform to the best horticultural practice and shall be appropriate to the various types of plants and the special requirements of each. Care shall be taken to preserve the natural character of each plant. All pruning operations shall be carried on under the supervision of the engineer and satisfactory to him.

The trunks of large growing deciduous trees shall be cleared of small side branches to a height of approximately six to seven feet and all inside crossing branches shall be removed. Lateral branches shall not be cut too far back nor excessively thinned out. The tree top shall be well framed in order that it will assume its normal and natural appearance as soon as possible. Approximately one-third of the tops of deciduous trees and shrubs having heavy tops shall be removed as directed by the engineer. "Leaders" shall not be removed or

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cut-back on trees normally having "leaders." All broken branches shall be removed with a clean cut.

Plants requiring excessive cutting or pruning which would ruin their appearance will be rejected.

All cut surfaces on hardy shade trees over one inch in diameter shall be painted with a mixture of one-fourth creosote and three-fourths tar or other approved materials.

Trees whose cambium is tender shall be treated with shellac instead of the above mixture.

Extra care must be used in the pruning of broadleaf evergreen trees, live oaks and magnolias. The branches of the live oak shall be thinned out to remove about one-half of the foliage. The magnolia shall be pruned by removing approximately three-fourths of its leaves rather than by cutting branches or twigs.

Balled evergreen shrubs shall not be pruned unless specifically designated by the engineer.

All broken or badly bruised roots shall be removed with a clean sharp cut.

**6.16 Preparation of Planting Pits:**

Planting stakes will be set by the engineer at the designated locations of all plants, except where group plantings are to be made of the same plants, such as vines and small shrubs. Each stake will bear the key number of the plant for the particular location.

Planting pits shall be dug square or round with vertical sides and flat bottoms. The topsoil and subsoil shall be placed in separate piles and before backfilling, shall be rendered loose and friable. The minimum sizes of planting pits shall be as follows:

Type of Plant	Minimum size of pit
Dwarf shrubs and vines	20 inch diameter and 14 inches deep
Small trees less than 1 inch caliper and large shrubs whose mature height is less than 7 feet	3 foot diameter and 2 feet deep
All trees commonly known as shade trees from 1 inch to 3 inch caliper; and large flowering trees and shrubs whose mature height is more than 7 feet.	4 foot diameter and 30 inches deep

For larger sizes of trees the pit sizes shall be increased.

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Before planting any plant, the bottom of the pit shall be thoroughly chopped up and dirt rendered friable.

### 6.17 Fertilizer:

Fertilizer in the amounts and of the kind shown on the plans or in the special provisions shall be applied to each plant designated on the plans or in the special provisions to be fertilized. The fertilizer shall be applied at the time of planting. Approximately one-third of the amount of fertilizer specified for each plant shall be mixed with the topsoil and placed in the bottom of the planting pit; approximately one-third shall be mixed with the soil which is to be placed in the pit around the roots of the plant and the remaining one-third shall be used with the soil at the surface of the ground as the backfilling is being completed. In no event will the contractor be allowed to dump the fertilizer into the planting pit, it shall always be thoroughly incorporated with the soil before such soil is used for backfilling. The contractor will be required to weigh the fertilizer required for each plant and place same in paper bags for distribution to the planting pits if deemed necessary by the engineer.

### 6.18 Planting and Backfilling:

All plants shall be carefully plumbed and planted in the previously prepared planting pits as directed by the engineer. Where indicated on the plans or directed by the engineer, group plantings of shrubs shall be outlined and made into beds. The topsoil removed from planting pits shall be placed in the bottom of each hole. Backfilling shall then be completed by adding as much of the subsoil as is necessary to completely fill the hole.

Where "Topsoil" is furnished under Item 5-7-1, it shall be used together with the topsoil removed from planting pits and the mixture placed in the bottom of the hole. Backfilling is then to be completed by using this mixture and as much of the subsoil as is necessary to fill the hole. If the amount of topsoil is sufficient to fill the hole, then no subsoil is to be used.

When "Special Soil" is furnished under Item 5-8-1, it shall be used for the entire backfill and no other soil shall be used.

The backfill shall be built up to a height of three to four inches above the surface of the ground around each plant in order to leave a cup or depression to catch and hold water. On steep slopes, the soil on the lower side of the plant shall

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be left sufficiently high to act as a dam to hold water. All soil used for backfilling shall be rendered loose and friable. No sticks, clods, sods or other material which would tend to form air pockets shall be included in the backfill and all such material shall be removed from the project. Sods may be used near the bottom of the pits in limited amounts only if broken into small pieces and only when approved by the engineer.

When backfilling around balled plants, the dirt shall be pressed or firmed around the balls of dirt as backfilling progresses. After backfilling has progressed from one-half to two-thirds the depth of the ball, the burlap covering must be cut away from the upper half of the ball and the remaining burlap spread or otherwise adjusted on the surface of the backfill in order to prevent the formation of air pockets.

When backfilling around bare rooted plants, the dirt must be worked in around the roots and thoroughly pressed or firmed at intervals during the process of backfilling. Roots must be well spread out and not cramped or crowded into the holes.

### 6.19 Water:

The contractor shall furnish water in sufficient quantities for proper irrigation of the plants. The plants shall be watered immediately after planting and at intervals as directed by the engineer until final acceptance.

### 6.20 Staking Trees:

All trees shall be staked and tied as soon after planting as possible. The contractor shall provide two stakes 2 inches x 2 inches x 8 feet long for each tree, placed uniformly throughout the project in order to present a neat appearance. The stakes shall be driven vertically into the ground two feet deep and close enough to the trunk of the tree to insure stability. The stakes and trunk shall be securely tied with black wire or hay wire by wrapping one end of the wire around the top of one stake and then by wrapping the trunk and the top of the other stake followed by wrapping the trunk again but beginning on the opposite side and finally back to the first stake, the whole forming a figure eight on each side of the tree. Folded burlap shall be securely wrapped around the trunk of each tree at the point of contact with wire before applying same in order to avoid injury to the tree.

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### 6.21 Staking Palms:

The contractor shall provide three stakes 2 inches x 4 inches x 6 feet long for each palm. The stakes shall be driven vertically into the ground two feet deep and six feet away from the palm spaced so as to form a triangle. Each stake shall be securely guyed to an angle post. Three strands of barbed wire shall be stapled to the outside of the stakes forming a fence. The three strands of barbed wire shall be "Stayed" halfway between stakes by making a vertical connection to each strand with barbed or black wire.

### 6.22 Finishing Surfaces Around Plants After Backfilling:

All excess dirt remaining after backfilling shall be spread evenly over the surface of the ground adjacent to the plants and shall be brought to a smooth even surface by raking or other hand methods. However, when directed by the engineer, the contractor will be required to remove any part or all excess dirt to other portions of the project or completely dispose of same beyond the limits of the highway right of way.

### 6.23 Transplanting:

All plants designated on the plans to be transplanted shall be properly dug, cared for, replanted, staked, pruned, mulched and watered as specified herein. Plants to be transplanted, balled and burlapped and those to be transplanted bare rooted shall be shown on the plans or in the special provisions.

### 6.24 Maintenance and Acceptance:

Upon completion of all items of the contract, the engineer will notify the contractor in writing that the contract is provisionally accepted and the contractor is released from all contractual obligations except maintenance of planted areas and replacement plantings. The contractor will be required to maintain all planted areas for sixty days after date of such provisional acceptance. Such maintenance shall include cultivation, watering, weeding, and any or all other horticultural work necessary to insure the life and growth of all plants.

At the expiration of this maintenance period, the engineer will make an inspection and prepare an estimate showing the amount of plant materials in an acceptable growing condition and other items complete, and the amount due the contractor for those items complete at their contract unit bid price. Plant materials which are not in an acceptable growing condition will not be included in the estimate. If the

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engineer decides that the plants which are not in an acceptable and growing condition are not detrimental to the appearance of the project as a whole, he may allow same to remain in place but no payment will be made therefor and the above estimate will be considered final.

If, on the date of this inspection, the engineer finds that the dead, missing, damaged or injured plant material is detrimental to the appearance of the project as a whole, he shall so notify the contractor in writing, deferring final acceptance until replanting is performed.

The contractor will then immediately upon receipt of such notification replace all plants itemized thereon, provided that the date for such replanting is not in conflict with Article 6.13, Seasonal Operations. Bare rooted plants which are to be replaced shall be Balled and Burlapped if so directed. Immediately upon the completion of this replanting work, the engineer shall make a final inspection and if all replantings have been made in accordance with the specifications, the engineer shall prepare the final estimate.

If the season is further advanced than provided in Article 6.13, Seasonal Operations, such replanting shall be performed during the following planting season. During the following planting season, all planting not previously accepted as shown on above notification, shall be replaced in accordance with these specifications. Upon completion of such replanting, the engineer shall prepare the final estimate.

Contract days stated in the contract shall apply to the initial construction period only (exclusive of the sixty day maintenance period) and will not include added time for subsequent replantings.

### MEASUREMENT AND PAYMENT

#### 6.25 Method of Measurement:

The various trees, shrubs, vines and plants will be measured by the plant and the number of plants actually planted, living and growing, shall be counted.

#### 6.26 Basis of Payment:

Fifteen per cent of the total cost of all plants shall be withheld until the final acceptance of all planting, provided this amount is equal to more than the total cost of the plants to be replaced. If this amount is less than the total cost of the plants to be replaced then the actual cost of the

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plants to be replaced shall be withheld in lieu of the fifteen per cent.

The number of plants planted and accepted, measured as provided above, shall be paid for at the contract unit price per each for the various plants, complete in place, which price and payment shall constitute full compensation for preparation of planting pits, pruning, fertilizing, planting, re-planting, transplanting, backfilling, staking and maintenance; for furnishing of all materials (except topsoil furnished under Item 5-7-1 and special soil furnished under Item 5-8-1), equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under the various item numbers as specified in the Summary Plant List of the Special Provisions.

## SECTION 7

### TOPSOIL

#### 7.01 Description:

This item shall consist of furnishing topsoil for use in backfilling the particular plants designated on the plans or in the special provisions in accordance with these specifications or as directed by the engineer.

### MATERIALS

#### 7.02 Topsoil:

The topsoil shall consist of approved mellow, loamy topsoil. Topsoil shall be approved by the engineer before the contractor will be permitted to use same on the project.

### CONSTRUCTION METHODS

#### 7.03 Application:

The topsoil shall be used in backfilling plants as specified under Article 6.18, Part 5, Division II. Unless otherwise specified the following amount of topsoil shall be provided for each plant:

Size of Planting Pit	Amount of Topsoil
4 foot diameter, 30 inches deep	1 cubic yard
3 foot diameter, 2 feet deep	½ cubic yard
20 inch diameter, 14 inches deep	¼ cubic yard



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MEASUREMENT AND PAYMENT

**7.04 Method of Measurement:**

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.

**7.05 Basis of Payment:**

The number of cubic yards of topsoil placed and accepted, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Topsoil," complete in place, which price and payment shall constitute full compensation for all hauling and for 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 5-7-1, Topsoil, per cubic yard.

**SECTION 8**

**SPECIAL SOIL**

**8.01 Description:**

This item shall consist of furnishing special soil for use in backfilling the particular plants designated on the plans or in the special provisions in accordance with these specifications or as directed by the engineer.

**MATERIALS**

**8.02 Special Soil:**

Special soil shall consist of acid muck obtained from swampy places or from the edges of fresh water streams or ponds; it may consist of good woods mold obtained from beneath oak, hickory, sweetgum or other hardwood trees or it may be obtained from areas supporting a growth of acid soil plants, either or a combination of any or all of the above. This soil shall consist only of acid soil, rotten roots, particularly decayed leaves, rotten wood or other decayed vegetable matter suitable for acid soil plants. All special soil shall be approved by the engineer before the contractor will be permitted to use same on the project.

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CONSTRUCTION METHODS

**8.03 Application:**

The special soil shall be used for backfilling plants as specified under Article 6.18, Part 5, Division II. When special soil is used in the backfill it shall be used exclusively.

MEASUREMENT AND PAYMENT

**8.04 Method of Measurement:**

Special soil 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.

**8.05 Basis of Payment:**

The number of cubic yards of special soil placed and accepted, measured as provided above, shall be paid for at the contract price per cubic yard for "Special Soil," complete in place, which price and payment shall constitute full compensation for all hauling and 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 5-8-1, Special Soil, per cubic yard.

SECTION 9

MULCHING PLANTS

**9.01 Description:**

This item shall consist of furnishing and applying mulch to plants in accordance with the plans and these specifications or as directed by the engineer.

MATERIALS

**9.02 Mulch:**

Mulch shall consist of partially decayed hay, rice straw or leaves, unless otherwise provided for on the plans or in the special provisions.

CONSTRUCTION METHODS

**9.03 Application:**

Mulch shall be spread evenly around each plant to a depth of approximately three inches over the surface of the ground

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to the edge of the planting pit or in the case of groups or beds of plants, it shall be spread over the entire bed. Mulch shall not be banked against the trunk of the plant but shall be placed so that a small space remains between the trunk and mulch. The plants shall be mulched as soon after planting as practicable. After the mulch is placed, it shall be held in place by scattering a small quantity of soil over it.

### MEASUREMENT AND PAYMENT

#### 9.04 Method of Measurement:

Mulching of plants will be measured by the plant and each plant mulched shall be counted.

#### 9.05 Basis of Payment:

The number of plants mulched and accepted, measured as provided above, shall be paid for at the contract unit price per plant for "Mulching Plants," 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 5-9-1, Mulching Plants, per plant.

## SECTION 10

### SEEDING

#### 10.01 Description:

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

### MATERIALS

#### 10.02 Seed:

The U. S. Department of Agriculture Circular 406 (April 1928) "Rules for Seed Testing," and subsequent revisions, will govern, unless otherwise stipulated in special provisions.

All grass seed shall be of the previous year's crop and shall be free of illegal weed seeds. Grass seeds will be rejected when they contain weed seeds in excess of one per cent.

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The following table shows Purity and Germination for the different seeds:

	Purity per cent	Germination per cent
Bermuda Grass .....	98	80
Carpet Grass .....	80	70

CONSTRUCTION METHODS

10.03 Seeding:

The area to be seeded shall be scarified lightly by harrowing, raking, or any other suitable method approved by the engineer, unless the seeding operations follow surface dressing. Seed shall be uniformly distributed by either hand or machine methods.

When seeding areas in order to augment native grass, the area to be seeded shall be mowed with a lawn mower before scarifying and after sowing a light dressing of fertilizer or topsoil shall be applied.

The seeded areas shall be lightly raked or dragged as directed and then rolled with a roller weighing not less than five hundred pounds. All seeded areas shall be watered and kept moist for a period of twenty-one days. If at the expiration of this period certain areas do not show sufficient germination in the opinion of the engineer, they shall be reseeded at the contractor's expense. The contract will not be accepted until sufficient germination and growth has been attained in the opinion of the engineer.

MEASUREMENT AND PAYMENT

10.04 Method of Measurement:

Seeding will be measured by the pound and the number of pounds of seed sowed shall be measured.

10.05 Basis of Payment:

The number of pounds of seed sowed and accepted, measured as provided above, shall be paid for at the contract unit price per pound for "Seeding," which price and payment shall constitute full compensation for furnishing all materials (except fertilizer or topsoil), equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 5-10-1, Seeding, per pound.

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**DIVISION II**  
**Part 6—Incidental Construction**

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DIVISION II—PART 6

**SECTION 1**  
**BEARING PILES**

**1.01 Description:**

This item shall consist of furnishing and driving precast concrete, untreated timber or creosoted timber 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 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 and 14 Inch Piles.....12,000 ft. lbs. per blow  
For 16 Inch and 18 Inch Piles.....20,000 ft. lbs. per blow

(b) Drivers for Timber Piles: Timber piles shall be driven with either 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 and the fall shall be so regulated as to avoid injury to the pile, and in no case shall it exceed 20 feet.

(c) 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.

(d) Jets: When water jets are used, the number of jets and nozzle volume and pressure shall be sufficient to erode the material adjacent to the piling freely. 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 gage shall be provided on the discharge pipe.

**MATERIALS**

**1.03 Concrete Piles:**

Concrete piles shall be constructed of Class "A" Concrete. The concrete used shall comply with the requirements for "Concrete."

Reinforcing steel used in concrete piles shall conform to

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the requirements for "Reinforcing Steel," 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) Creosoted Piles: Creosoted piles shall be Southern Yellow Pine, unless the plans specify another species. They shall be creosoted with a 16 pound treatment in compliance with the specifications under "Preservative Treatment for Timber."

(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 one-third 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  $\frac{3}{4}$  inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two 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 1 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  $2\frac{1}{2}$  inches. All knots shall be trimmed close to the body of the pile.

(d) Dimensions: Round 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

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The minimum diameter of piles at a section 4 feet from the butt, measured under the bark, shall be as follows:

Length of Pile	Diameter in inches	
	Douglas Fir	All other Species
	Southern Yellow Pine	
	Southern Cypress	
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. Square piles shall have the dimension shown on the plans.

CONSTRUCTION METHODS

1.05 General:

(a) Order Lists for Piling: 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.

(b) Piling Inspections: The contractor shall furnish the Commission, through the Resident Engineer, a copy of each of his orders for creosoted and untreated piling in order that the Commission 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 Commission and supplied by them to inspectors.

1.06 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 reinforcements for same until he has been furnished the lengths and number required by the engineer.

(b) Pouring: Concrete shall be placed and vibrated in accordance with the general method of placing concrete as specified under "Concrete." The piles shall be cast separately or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until four days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed continuously in each pile. The completed piles must be free from stone pockets, porous spots, or other defects, and be straight and true to the form specified. The forms



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shall be true to line, built of dressed lumber and 1½ inch chamfer strip shall be used in all corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed.

All exposed surfaces of the pile shall be given a rubbed finish.

(c) Curing: Concrete piling shall be cured as required for Portland cement concrete 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: As soon as the piles have set sufficiently to permit (not less than 15 days) they may be removed from the form bed and piled in a curing pile 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: No pile shall be driven until it has set for at least twenty-eight days and in cold weather this period may be increased as determined by the engineer.

(g) High-Early-Strength Cement: Where the use of high-early-strength cement is permitted by the engineer, the curing period, and the minimum age before handling or driving may be reduced to ten days.

### 1.07 Driving:

#### (a) General:

1. Preparation for Driving: All excavation of foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving a clean, solid surface to receive the concrete.

2. Protection of Heads: The heads of all concrete piles and the heads of timber piles, when the nature of the driving is such as to injure them unduly, shall be protected by caps of approved design, preferably having a rope or other suitable

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cushion next to the pile head and fitting into a casting which in turn supports a timber shock block. When the area of the head of any timber pile is greater than that of the face of the hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile and thus avoid, as far as possible, the tendency to split or shatter the pile.

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 the final two feet of penetration shall be obtained without the aid of the jet.

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, whether of wood or of concrete shall not subject them to excessive and undue abuse producing crushing and spalling of the concrete or injurious splitting, splintering or brooming of the wood. Any pile so injured in driving or handling shall be replaced by a new pile, the injured part replaced by splicing or other remedial measures adopted, all as directed by the engineer and at the contractor's expense. Any pile so out of line or plumb as to impair its usefulness or the appearance of the structure shall be pulled and re-driven or an additional pile driven, as required by the engineer and at the contractor's expense.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again if required by the engineer.

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.

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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	$P = \frac{2WH}{S+1}$
For single-acting steam hammers	$P = \frac{2WH}{S+0.1}$
For double-acting steam hammers	$P = \frac{2E}{S+0.1}$

In the above formulas  $P$  = safe load per pile in pounds;  $W$  = weight of falling hammer in pounds;  $H$  = height of fall in feet;  $S$  = the average penetration per blow in inches for the last 5 blows of a gravity hammer or the last 20 blows of a steam hammer;  $E$  shall be determined by counting the blows per minute and taking from the manufacturer's catalog the value in foot-pounds per blow, for the particular hammer being used, operating at the given rate.

The above formulas are applicable only when:

- I The hammer has a free fall.
  - II The head of the pile is free from broomed or crushed wood-fiber or other serious impairment.
  - III The penetration is at a reasonably quick and uniform rate.
  - IV There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" before inserting the value in the formula.
  - V The weight of pile is not more than the weight of the hammer used, if the hammer used is of the gravity type.
- The bearing powers of timber piles as determined by the foregoing formulas shall be considered effective only when they are less than the crushing strength of the piles.

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.

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The carrying capacity of jetted piles shall be determined by actual tests or by the same method and formula as in the case of unjetted piles, provided that no jet be used during the test blows.

### (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 one hundred 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 the driving is completed, the concrete at the end of the pile shall be cut away leaving the reinforcing steel exposed for a length of 50 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: Creosoted piles shall not be driven until they have been seasoned a minimum of 30 days after treatment.

2. Storage and Handling: The method of storage and handling shall be such as to avoid injury to the piling. Special

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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 3 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 paid for as hereinafter specified.

Whenever the engineer considers it necessary to splice piling which are delivered on the work, the splice shall be made in accordance with the Commission's standard splice plan. This splice consists of four 3 inch x 8 inch timber 8 feet long bolted to each section of pile with seven  $\frac{3}{4}$  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. For each splice made at the direction and under the supervision of the engineer an extra allowance of 10 feet of piling will be allowed, this allowance to cover the cost of all material, labor and delay of work incident to making splice and to be in addition to the total length of piling left in place which will be paid for as hereinafter specified.

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.

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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 creosoted 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 three applications of hot creosote oil and shall then be covered with a coat of hot roofing pitch or other suitable bituminous material. Upon this shall be placed a sheet of galvanized iron, No. 28 gage, 18 inches square. The cover shall be bent down over the pile at an angle of approximately 45 degrees.

### 1.08 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.

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 elevation of 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 above 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 above specifications for this class of work under "Construction Method".

(b) Loading: After the test pile has been driven in accordance with these specifications it shall, if called for in the contract, be loaded with any kind of material suitable to the engineer.

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The loading platform or box shall be so constructed that readings of the settlement may be taken directly on the pile. The loading platform or box shall be so built as to carry safely any amount of the approved material equal in weight to twice the loading shown on the plans. Broomed or split portions of the pile shall be cut off, leaving a sound surface to support the platform.

The loading material shall be applied gradually, and without causing vibration, as directed by the engineer, and shall be so placed that at all times the load will be concentric with the pile. The loading material shall usually be placed within 24 hours after the pile is driven, unless otherwise directed by the engineer.

The capacity of any pile so tested shall be considered equal to  $\frac{1}{2}$  the load carried by the pile without exceeding a total permanent settlement of  $\frac{1}{4}$  inch in 48 hours, unless otherwise specified by the engineer.

(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.

### 1.09 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  $\frac{2}{3}$  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 and the depth of each hole shall be determined by the engineer. A minimum penetration of 15 feet will be required for all piles.

## MEASUREMENT AND PAYMENT

### 1.10 Method of Measurement:

(a) Piling: Precast concrete piles, untreated piles and creosoted piles driven in the locations designated by the plans or by the engineer 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, but measurement will be made only when the amount of cut-off exceeds one linear foot on any

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particular pile. No measurement of cut-offs will be made where they have been caused by unnecessary crushing, brooming, splitting or other injuries resulting from careless driving.

(c) Extensions: Measurement of extensions on precast concrete piles will be by the linear foot, complete in place. The total number of linear feet in this case shall be determined by adding the gross length of the extension cast on the pile to the original length of the pile cast. No measurement will be made for extensions made necessary by damage to the piles during driving.

(d) Splices: Measurement of splices on timber piles will be by the linear foot, the number of which will be determined by allowing ten linear feet of piling for each splice made. The total number of linear feet in this case shall be determined by adding ten feet to the net length of pile left in place in the finished structure.

No measurement will be made for splices except when they are made at the direction and under the supervision of the engineer.

(e) Jetting: The number of jetted piles to be paid for shall be the number of individual concrete or timber piles jetted into place by order of the engineer.

(f) Unloaded Test Piles: The number of test piles to be paid for shall be the number of individual concrete or timber test piles, as the case may be, furnished and driven as directed by the engineer.

Test piles utilized as permanent piles will be measured as test piles, and no measurement of pay footage for such piles will be allowed.

Cut-offs of test piles will not be included in any pay footage.

(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.

### 1.11 Basis of Payment:

(a) Piling: The number of linear feet of completed and accepted piling, measured as provided above, shall be paid for at the contract unit price per linear foot for "Precast Concrete Piles", "Untreated Timber Piles", or "Creosoted Timber Piles", as the case may be, which price and payment shall



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constitute full compensation for all materials, including collars and galvanized iron covers, temporary bracing, equipment, tools, labor, and incidentals necessary to complete the item. It shall also include the placing, but not the furnishing of metal shoes.

The contract price per linear foot shall also include all materials and labor required for bolting, wrapping or fastening timber fender piles.

In case battered piles are required by the plans, the rate of payment shall not be changed.

(b) Cut-Offs: Payment for cut-offs, measured as provided above, shall be made at the rate of one-half the contract unit price per linear foot for "Precast Concrete Piles", "Untreated Timber Piles", or "Creosoted Timber Piles", as the case may be.

(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 shall be made at the contract unit price per linear foot for "Untreated Timber Piles" or "Creosoted Timber Piles", as the case may be. Each splice made in accordance with these specifications, and accepted by the engineer, shall be paid for as ten linear feet of piling of the type being spliced, which price shall include all materials, equipment, and labor required to complete the item.

(e) Jetting: Payment for jetting piles shall be made at the contract unit price per pile jetted under "Jetting Timber Piles" or "Jetting Concrete Piles" as the case may be, which price and payment shall be full compensation for all materials, equipment, and labor required to complete the item.

(f) Unloaded Test Piles: This work will be paid for at the contract unit price each for "Unloaded Test Piles," complete in place. This price will 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 will include all materials, equipment, tools, labor and work incidental to constructing the platform or box, procuring and

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placing the loading material, removing the platform or box and material, and disposing of same as directed by the engineer. No payment will be made for test loadings that are not made in accordance with these specifications or as directed by the engineer and accepted by him.

(h) Pilot Holes: Payment for pilot holes will be made at the contract unit price per 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 6-1-1, 12 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-2, 14 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-3, 16 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-4, 18 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-5, 20 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-6, 24 Inch Precast Concrete Piles, per linear ft.
- Item 6-1-7, Untreated Timber Piles, per linear ft.
- Item 6-1-8, Creosoted Timber Piles, per linear ft.
- Item 6-1-9, Jetting Timber Piles, each.
- Item 6-1-10, Jetting Concrete Piles, each.
- Item 6-1-11, Unloaded Concrete Test Piles, each.
- Item 6-1-12, Unloaded Timber Test Piles, each.
- Item 6-1-13, Loading Test Piles, each.
- Item 6-1-14, Pilot Holes, 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:

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. It shall be untreated unless the plans specifically call for the use of creosoted

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timber. When creosoted timber is called for, it shall receive a 16 pound full cell treatment in accordance with the provisions of "Preservative Treatments for 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.

### 2.03 Concrete Sheet Piles:

The materials entering into the construction of concrete sheet piles shall comply with the requirements for "Concrete" and "Reinforcing Steel", of these specifications.

### 2.04 Steel Sheet Piles:

All steel used for sheet piles shall comply with the requirements for carbon steel under "Structural Steel", of these specifications.

## CONSTRUCTION METHODS

### 2.05 Construction:

Timber, concrete and steel sheet piling shall be constructed in strict accordance with the detailed design.

### 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 timbers, and all abrasions, after having been carefully trimmed, shall be coated with two applications of a mixture of 60 per cent creosote oil and 40 per cent roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

## MEASUREMENT AND PAYMENT

### 2.10 Method of Measurement:

(a) Timber Sheet Piles: Timber sheet piles shall be measured by the 1,000 feet, board measure, of timber sheet piling, complete in place and accepted.

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(b) Concrete Sheet Piles: Concrete sheet piles shall be measured by the cubic yard of concrete sheet piling, complete in place and accepted. No measurement will be allowed for reinforcing steel.

(c) Steel Sheet Piles: Steel sheet piles shall be measured by the pound of steel sheet piling, complete in place and accepted.

### 2.11 Basis of Payment:

The number of 1,000 feet, board measure of timber sheet piles, cubic yards of concrete sheet piles or pounds of steel sheet piles, measured as provided above shall be paid for at the contract unit price for "Untreated Timber Sheet Piles", "Creosoted Timber Sheet Piles", "Concrete Sheet Piles" or "Steel Sheet Piles", 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 under:

- Item 6-2-1, Untreated Timber Sheet Piles, per 1000 feet board measure.
- Item 6-2-2, Creosoted Timber Sheet Piles, per 1000 feet board measure.
- Item 6-2-3, Concrete Sheet Piles, per cubic yard.
- Item 6-2-4, Steel Sheet Piles, per pound.

## SECTION 3

### PRESERVATIVE TREATMENTS FOR TIMBER

#### 3.01 Description:

Preservative treatments for timber, lumber and piling shall consist of creosoting or other treatments, as specified on the plans or in the special provisions.

All timber, lumber and piling to be creosoted shall receive and retain, unless the oil has been injected to refusal, 16 pounds of oil per cubic foot of timber.

#### 3.02 Equipment:

Treating plants shall be equipped with the thermometers and gages necessary to indicate and record accurately the conditions at all stages of treatment, and all equipment shall be maintained in a condition satisfactory to the purchaser.

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The apparatus and chemicals necessary for making the analyses and tests required by the purchaser shall also be provided by plant operators, and kept in condition for use at all times.

MATERIALS

3.03 Creosote:

(a) Grade: Grade 1 creosote oil shall be used for all treatment. Creosote-coal-tar solution may be used when specified on the plans or in special provisions.

(b) Quality: The creosote and creosote-coal-tar shall comply with the following requirements:

The creosote oil shall be distillates of coal-gas tar or coke-oven tar. The creosote-coal-tar solution shall be a coal-tar product, of which at least 80 per cent shall be a distillate of coal-gas, or coke-oven tar, and the remainder shall be refined or filtered coal-gas tar or coke-oven tar.

	Creosote Oils Grade 1	Pressure Treatment Creosote Oils Cresote Coal-Tar Solution
1. It shall not contain water in excess of, per cent. ....	3	3
2. It shall be fluid at 15°C. and crystal free at 38°C. ....	..	..
3. It shall not contain matter insoluble in benzol in excess of, per cent. ....	0.5*	2*
4. The specific gravity at 38°/15.5°C. shall be not less than. ....	1.03	1.05-1.12
5. The distillate, based on water-free oil, shall be within the following limits: Up to 210°C., not more than, per cent. ....	5	5
Up to 235°C., not more than, per cent. ....	25	25
6. Coke residue of oil shall not exceed, per cent. ....	2	6

\*Note: An increase of 1 per cent in matter insoluble in benzol shall be permitted for used oil in the working tanks, provided it can be shown that the oil when fresh was of the quality specified.

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### CONSTRUCTION METHODS

#### 3.04 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 1 inch or more between each two 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 Seasoning for Southern Yellow Pine: Southern Yellow Pine may be steam seasoned 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 steamed in the cylinder at not more than 20 to 25 pounds pressure per square inch for not more than 12 hours for sawed timber and not more than 20 hours for piles, temperature not to exceed 274°F., the maximum pressure being reached in not less than 2 hours. The cylinder shall be provided with vents to allow the escape of air and insure proper circulation of the steam. After steaming is completed a minimum vacuum of 22 inches shall be maintained for not less than 2½ hours, or until the wood is as dry and free from moisture as practicable. The cylinder shall be relieved continuously or frequently enough to prevent condensate from accumulating in sufficient quantity to reach the wood. Before the preservative is introduced the cylinder shall be drained of condensate.

(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.

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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.

### 3.05 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.

### 3.06 Creosote Treatments, Pressure:

(a) Full Cell Process Southern Yellow Pine: Southern Yellow Pine shall be treated by the full-cell process, as follows:

The timber shall be subjected to a vacuum of sufficient intensity and duration to render the wood as dry and free from air as practicable, and to permit a retention of the specified number of pounds of preservative per cubic foot of wood.

The preservative shall be introduced between 165°F. and 200°F., and the cylinder filled without breaking the vacuum. The pressure shall then be raised to and maintained at a minimum of 100 pounds per square inch or until the specified quantity of preservative is injected into the wood, or until the purchaser's representative is satisfied that the largest volumetric injection that is practicable has been obtained. The temperature of the preservative during the pressure period shall be not less than 150°F., nor more than 200°F., and shall average at least 180°F. After the pressure is completed the cylinder shall be emptied speedily of preservative, and a vacuum of not less than 22 inches promptly created and maintained until the wood can be removed from the cylinder free of dripping preservative.

(b) Full Cell Process, Douglas Fir: Douglas Fir shall be treated by the full-cell processes as follows:

It is not required that air-seasoned or kiln dried Douglas Fir be boiled under a vacuum, but it may be desirable to hold the material in creosote bath maintained at a temperature of 180°F. to 190°F. for a length of time which, combined with the pressure period, is, in the judgment of the operator necessary to secure the specified absorption.

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Following the heating period, in the case of air-seasoned material, and the period of seasoning under vacuum in the case of material artificially seasoned, the cylinder shall be filled with creosote and pressure applied as required to a maximum limit of 175 pounds per square inch and maintained, taking into consideration the quantity of creosote absorbed during the bath, until the specified absorption of creosote has been obtained.

Temperature of the creosote during the pressure period shall be as high as possible with a minimum limit of 160°F. and a maximum limit of 200°F.

After the pressure is completed, the cylinder shall be emptied of creosote and a vacuum of at least 20 inches promptly created and maintained for a sufficient period of time to free the material of dripping creosote.

(c) Penetration: The range of pressure, temperature, and time duration shall be controlled so as to result in a maximum penetration by the quantity of preservative injected. The vacuum requirements stipulated are in inches of mercury at sea level, and necessary corrections shall be made for altitude.

In southern yellow pine the preservative shall permeate all of the sapwood and as much of the heartwood as practicable.

In Douglas fir the minimum penetration for the specified amount of creosote oil shall be as follows:

Specified Amount of Creosote Per Cubic Foot = 16 pounds	
Piling .....	1.00 inch
Timber 12 inches by 12 inches and larger.....	1.00 inch

For timbers less than 12 inches by 12 inches the required depth of penetration shall be determined by the formula

$$P = P_s \frac{R}{R_s}$$

Where P = required penetration.

$P_s$  = specified penetration for 12 inch by 12 inch timbers.

R = ratio of the volume of the piece in question to its superficial area.

$R_s$  = ratio of the volume of a 12 inch by 12 inch timber to its superficial area.

The penetration of the preservative shall be based on black or dark oil, and in no case will light discoloration of the wood, due to treatment, be taken into consideration in measuring the depth of penetration.



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Tests for penetration shall be made by taking borings with an increment borer, or a  $\frac{5}{8}$  inch augur, all holes so bored to be plugged by the contractor with tight-fitting creosoted plugs.

As many penetration tests of timber and piling shall be made as is considered necessary by the inspector. In the case of piling, the holes shall be bored midway between the ends.

In the case of timber and lumber, every fourth stick of the charge may be bored.

### 3.07 Creosote Treatments, Non Pressure:

(a) Use: Non pressure treatments shall not be used except when specifically shown on the plans or specified in the contract.

(b) Open-Tank Treatments:

1. General Requirements: Open tank treatment shall consist of a hot bath treatment or a hot and cold bath treatment as may be specified.

All timber to be treated shall be free from dirt, grease or other foreign matter which will in any way hinder the free penetration of the preservative. Framing shall be done before treatment. Round timber or timber with wane shall have the rough bark and inner bark removed as specified for timber piling in "Bearing Piles."

All tanks used in the open tank process shall be of sufficient size to allow free circulation of the liquid around the largest amount of timber being treated in any operation.

Sufficient liquid shall be maintained in the tanks to completely immerse the timber. When a number of pieces are being treated at each operation, each stick shall be separated from the others on all sides by square or round spacers not less than  $\frac{1}{4}$  inch in least dimension. Suitable slings and handling devices shall be provided for the transfer of material necessary during the complete process without disturbing the stacked position of the pieces in the bundle.

For hot bath treatments at least one tank shall be supplied having suitable steam coils or other heating device to keep the liquid at a uniform temperature of not less than 240°F. throughout the tank during the complete process.

For hot and cold bath treatments at least one hot tank shall be supplied as for the hot bath treatment and one cold tank having the same capacity as the hot tank. The cold tank shall be equipped with suitable cold water coils or water

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jackets, so that the temperature of the liquid at the time of immersion of each batch of timber shall be no higher than the surrounding atmospheric temperature.

The time of immersion as specified below is for southern yellow pine. The specified time of immersion shall be increased  $66 \frac{2}{3}$  per cent for southern cypress and Douglas fir.

2. Single or Hot Bath Treatment: The timber shall be completely immersed in preservative in the hot tank, which shall be maintained at a temperature of 190°F. for seasoned timber and 230°F. for timber not seasoned. A tolerance of 10 degrees in either direction is permissible. For seasoned timber the immersion shall be for a period of not less than 15 minutes for 2-inch timber with an increase of 5 minutes in the immersion period for each additional inch in thickness. For unseasoned timber, the immersion period shall be doubled.

3. Ordinary Hot and Cold Treatment: The timber shall be completely immersed in preservative in the hot tank, which shall be maintained at a temperature of 190°F. for seasoned timber and 230°F. for timber not seasoned. A tolerance of 10 degrees in either direction is permissible. For seasoned timber the immersion shall be for a period of not less than 15 minutes for 2-inch timber with an increase of 5 minutes in the immersion period for each additional inch in thickness. For unseasoned timber the immersion period shall be doubled. At the end of this period the timber shall be removed from the hot tank and immediately immersed in the cold tank. At the time of transfer the preservative in the cold tank shall have a temperature as low as possible, but in no case higher than the surrounding air temperature. The timber shall be completely immersed in the cold tank for a period one-half as long as for the hot bath.

Successive charges from the hot tank may be placed first in one cold tank and the next in a second cold tank in order to keep the cold tank temperature as low as possible at the time of immersion. Should the contractor supply a cold tank capable of handling all material and with a cooling system which will secure the specified temperature at the time of all cold treatments as specified, only one cold tank may be required. Single cold tank equipment shall be subject to the approval of the engineer.

4. Heavy Hot and Cold Treatment: The requirements for this treatment are the same as those specified above for the ordinary hot and cold treatment except that the time of im-

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mersion in the cold bath shall be the same as the time of immersion in the hot bath.

### (c) Brush Treatment:

All timber to be given brush treatment shall be free from atmospheric moisture, and in no case shall brush treatment be applied when the surface of the timber is wet. The surfaces to be treated shall be free from dirt, grease, or other foreign matter which will in any way hinder the maximum penetration of the preservative.

The preservative shall be heated in proper receptacles immediately adjacent to the point of application and shall be applied within the temperature range of 170°F. to 190°F. for seasoned wood and 220°F. to 240°F. for unseasoned wood.

A minimum of 2 coats shall be applied to all surfaces to be treated except cut ends, joints and mortises, which shall be given 3 coats. Each coat shall be allowed to penetrate before applying the next coat. All checks, bolt holes and cracks shall be run full of the preservative oil and an extra heavy treatment shall be given to knotty spots.

### (d) Spray Treatment:

The condition of the timber prior to spray treatment shall conform to the requirements specified for brush treatment.

The temperature of the preservative shall be maintained at 240°F. The shortest length of hose practicable shall be used to prevent undue chilling between the spray tank and nozzle. Preservative shall be renewed frequently in the spray tank to prevent chilling. The spray shall be applied with a good pressure and only fine enough to prevent waste, until the preservative begins to run. Equipment employing air pressure which has a cooling effect on the hot preservative shall not be used.

Two liberal applications shall be made allowing sufficient time for the absorption of the first application before the second is made.

## MEASUREMENT AND PAYMENT

### 3.08 Method of Measurement:

No measurements will be made for preservative treatment of timber except as provided under the various items requiring the use of preservative treatment.

### 3.09 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.

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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. 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) Steel Structures: Steel bridges, including handrail, steel towers, etc., shall be painted with three coats of paint, as follows:

1. Shop coat—Red lead paint
2. First field coat—Red lead paint
3. Second field coat—Aluminum paint

Alternate coats for the second and third coats specified above may be used only when the written approval of the engineer has been obtained.

(b) Timber Structures: All handrails and posts of timber bridges, and other timber structures when specified on the contract drawing, shall be painted with three 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 two coats of paint as follows:

1. First coat—White lead paint
2. Second coat—White lead paint

(d) Blast Plates: Blast plates and hangars shall be painted on all surfaces with three 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 Stripe: The number of coats, width of stripe, and locations where required shall be as specified on the plans.

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4.02 Composition:

(a) Red Lead Paint: This paint shall be made to meet the following requirements:

	Min.	Max.
Pigment, by weight, per cent . . . .	74.0	81.0
Vehicle, by weight, per cent . . . .	19.0	26.0

The pigment shall be composed of Red Lead one hundred (100) per cent.

The vehicle shall be composed of:

Raw Linseed Oil, per cent . . . . .	90.0
Turpentine, per cent . . . . .	5.0
Liquid Drier, per cent . . . . .	5.0

The resulting paint shall be of a workable consistency and when brushed on a smooth, vertical iron surface, shall dry hard and elastic without running, streaking or sagging. It shall dry hard and tough in not more than 24 hours under normal conditions of temperature and humidity.

One gallon of finished paint shall weigh not less than 24.2 pounds.

Note: Tinting may be required by the engineer to the extent of 1 oz. lamp black, paste form, to 1 gallon finished paint.

(b) White Lead Paint: This paint shall be made to meet the following requirements:

	Min.	Max.
Pigment, by weight, per cent . . . .	60.0	64.0
Vehicle, by weight, per cent . . . .	36.0	40.0

The pigment shall be composed of:

Basic Sulphate White Lead,		
per cent . . . . .	65.0	75.0
Zinc Oxide, per cent . . . . .	25.0	35.0

The vehicle shall be composed of:

Raw Linseed Oil, per cent . . . . .	90.0
Turpentine, per cent . . . . .	5.0
Liquid Drier, per cent . . . . .	5.0

Note: If desired, the basic sulphate of lead may be replaced with basic carbonate of lead or a mixture of basic carbonate of lead and basic sulphate of lead. The lead and zinc pigments may be introduced in the form of any pre-

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ferred mixture of basic carbonate white lead, basic sulphate white lead or leaded zinc, provided the requirements as to composition are met. The total lead dissolved in dilute acetic acid and hot ammonium acetate, weighed as lead sulphate, and this weight multiplied by the factor 0.883 is the lead pigment. It is not possible to determine the amount of lead carbonate and lead sulphate when carbonates or sulphates of other metals, such as calcium, are present. Also neither basic lead carbonate nor basic lead sulphate are definite compounds. The factor to convert  $PbSO_4$  to  $(PbCO_3)Pb(OH)_2$  is 0.854, to convert  $PbSO_4$  to  $PbSP_2PbO$  is 0.868 and to convert  $PbSO_4$  to  $(PbSO_4)_2PbO$  is 0.913. The arbitrary factor 0.883 is the mean of largest and smallest of these factors.

(c) Manufacture of Lead Paint: The pigments entering into the composition of the paint shall be thoroughly machine ground together in oil and thinned by the addition of oil. Turpentine or Japan Dryer shall only be used to the extent specified. The quantity of vehicle specified above shall include the oil used in grinding.

(d) Aluminum Paint (Powdered Pigment): This paint shall meet the following requirements:

Aluminum Powder .....2.0 pounds  
Varnish .....1.0 gallon

The powder and the vehicle shall be delivered separately, the powder in bulk and the varnish in 5 gallon cans or barrels. The paint shall be mixed at the place where it is to be used, and no more paint shall be mixed at any time than the amount that can be used on that particular day. The contractor shall equip himself with a reliable, accurate set of scales, graduated to the tenth part of an ounce.

(e) Aluminum Paint (Paste Pigment): This paint shall meet the following requirements:

Aluminum Paste .....2.0 pounds  
Varnish .....1.0 gallon

The paste and the vehicle shall be delivered separately, the paste in bulk and the varnish in 5 gallon cans or barrels. The paint shall be mixed at the place where it is to be used, and no more paint shall be mixed at any time than the amount that can be used on that particular day. The contractor shall equip himself with a reliable, accurate set of scales, graduated to the tenth part of an ounce.

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(f) Graphite Paint: This paint shall be made to meet the following requirements:

	Min.	Max
Pigment, per cent.....	30.0	35.0
Boiled Linseed Oil, per cent.....	65.0	70.0
Drier, per cent.....	5.0	6.0
Turpentine and volatile matter, per cent.....	3.0	6.0

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.

(g) Bituminous Paint (Blast Plate): This paint shall be made to meet the following requirements:

	Min.	Max.
Water (by evaporation at 100°C), per cent..	45.0	50.0
Inert Mineral Ash, per cent.....	5.5	6.5
Bitumen (by differences), per cent.....	44.0	49.0

(h) Traffic Stripe Paint: This material shall be made from an asphalt and volatile naphtha. It shall be thoroughly mixed, free from lumps, water or foreign substances.

MATERIALS

4.03 Vehicles:

(a) Linseed Oil, Raw: Linseed oil shall be the pure oil pressed from flaxseed and shall conform to the following requirements:

	Min.	Max.
Specific Gravity 15.5°/15.5°C .....	0.931	0.936
Acid Number .....		4.0
Saponification Number .....	189.0	195.0
Unsaponifiable Matter, per cent .....		1.50
Iodine Number (Wijs) .....	177.0	
Loss on Heating at 105 to 110°C., per cent .....		0.2
Color—Not darker than a freshly prepared solution of 1.0 gram potassium dichromate in 100 cc. pure sulphuric acid (Sp. Gr. 1.84).		
Foots, per cent		
Heated Oil .....		1.0
Chilled Oil .....		4.0

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The method of test shall be in accordance with A.S.T.M. Serial Designation D 234-28.

(b) Linseed Oil, Boiled: Boiled linseed oil shall be pure linseed oil that has been treated by heating and incorporating compounds of lead and, at the option of the manufacturer, suitable compounds of other drying metals so as to produce a product that will dry rapidly. It shall be clear, free from sediment, and shall conform to the following requirements.

	Min.	Max.
Time of drying on glass, hours .....		18.0
Specific Gravity, 15.5°/15.5°C. ....	0.931	0.945
Acid Number .....		7.5
Saponification Number .....	189.0	195.0
Unsaponifiable Matter, per cent .....		1.50
Iodine Number (Wijs) .....	170.0	
Loss on Heating at 105 to 110°C, per cent .....		0.2
Ash, per cent .....		0.50
Lead, per cent .....	0.05	

The method of test shall be in accordance with A.S.T.M. Serial Designation D 260-33.

(c) Vehicle for Aluminum Paint: The vehicle shall be a varnish and shall fulfill the following requirements:

Appearance—Clear and transparent.

Non-Volatile Matter—Not less than 50 per cent by weight  
Set to touch—In not less than 30 minutes and not more than 6 hours

Dry Hard and Tough—In not more than 24 hours

Viscosity—Consistency to correspond to tubes A to D  
Gardner-Holdt Air Bubble Viscosimeter

Toughness—Shall pass a 60 per cent Kauri Reduction test at 75° F.

1. Working Properties: When mixed with aluminum powder in the preparation of 2 pounds of powder to one gallon of vehicle, the resulting paint shall give a free flowing, smooth continuous coating, free from breaks and sags when applied to a smooth vertical surface.

2. Methods of Analysis: The method of analysis shall be as given by the Federal Specification Board under specifications TT-V-81.



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4.04 Pigments:

(a) Red Lead: The red lead pigment shall consist entirely of lead oxide, free from all adulterants, and shall meet the following requirements:

True red lead, $Pb_3O_4$ , minimum, per cent...	95.0
Total impurities, including moisture, soluble matter, water, and matter insoluble in a mixture of nitric acid and hydrogen peroxide, maximum, per cent.....	1.0
Lead monoxide (PbO).....	remainder
Coarse particles retained on a No. 325 sieve, maximum, per cent.....	1.0

The method of test shall be in accordance with A.S.T.M. Serial Designation D 49-37.

(b) White Lead:

1. Basic Sulphate White Lead: This material shall conform to the following formula:

Lead oxide, per cent .....	15.0 to 28.0
Zinc oxide, max., per cent .....	5.0
Total impurities, including moisture, max., per cent .....	1.0
Coarse particles (total residue retained on a No. 325 sieve), max., per cent .....	1.0
Lead sulfate .....	remainder

Method of test shall be in accordance with A.S.T.M. Serial Designation D 34-33.

Zinc Oxide: The material shall conform to the following formula:

Coarse particles retained on a No. 325 sieve, max., per cent .....	1.0
Zinc oxide, min., per cent .....	98.0
Total sulfur, max., per cent .....	0.2
Total impurities, including moisture, max., per cent .....	2.0

The method of test shall be in accordance with A.S.T.M. Serial Designation D 34-33.

2. Basic Carbonate of Lead: The material shall approximately conform to the formula  $2 PbCO_3 \cdot Pb(OH)_2$ , and the pigment shall conform to the following requirements:

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Lead Carbonate, per cent.....	65.0 to 75.0
Moisture and other volatile matter, max., per cent .....	0.7
Total other impurities, max., per cent .....	1.0
Coarse particles (total residue retained on a No. 325 sieve), max., per cent .....	1.0

The method of test shall be in accordance with A.S.T.M. Serial Designation D 34-33.

Zinc Oxide: Zinc oxide shall be the same as that described above.

(c) Aluminum Powder: This material shall consist of aluminum powder in the form of polished flakes, shall contain no filler or adulterant such as mica, magnesium silicate, etc. A sample of the powder, when tested on standard mesh sieve, shall meet the following requirements:

Coarse particles using alcohol or Mineral Spirits as wash liquid	
Total residue retained on No. 200 sieve, max., per cent .....	0.5
Total residue retained on No. 325 sieve, max., per cent .....	3.0
Extracted fatty or oily matter (polishing lubricant), max., per cent .....	3.0

(d) Aluminum Paste: The aluminum paste shall consist of:	
Pigment, min., per cent .....	63.0
Liquid, max., per cent .....	37.0
Moisture, max., per cent .....	0.5

Liquid portion with which the aluminum bronze powder is compounded to form the paste shall be completely volatile at 105°C (221°F).

(e) 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 three per cent of material retained on a 325-mesh sieve. The prepared pigment must contain not less than thirty-five per cent nor more than fifty per cent of graphite in the form of graphite carbon.

(f) Bituminous Paint (Blast Plate):

1. The bitumen shall be a pure, highly adhesive asphalt dispersed in water and, after drying, shall be incapable of be-

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coming 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 homogeneous product.

(g) Traffic Stripe Paint: The asphalt base must be of such a nature that it will readily mix with the vehicles, after standing in storage over a long period. Must be quick drying, and shall otherwise conform to the following requirements:

Tests:	Min.	Max.
1. Flash Point, Tag. Open Cup °F . . . . .		115
2. Saybolt Furol Viscosity at 122°F.		
Sec. . . . .	55	70
3. Distillation (Asphalt Institute Modified):		
Total off at 437°F., per cent . . . . .	44.0	
Total off at 600°F., per cent . . . . .	56.0	
Total off at 680°F., per cent . . . . .		63
4. Test on Residue:		
Penetration at 77°F. . . . .		15
Melting Point, °F. . . . .	190	
Soluble in CS <sub>2</sub> , per cent . . . . .	99.5	

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Additionally: Meal strip 1 inch wide dipped in paint 4 inches and suspended in air, room temperature, shall be dry to touch in not more than 20 minutes.

Method of Tests: Shall be in accordance with latest methods of American Association of State Highway Officials.

4.05 Miscellaneous:

(a) Turpentine: This material shall be reasonably free from suspended matter, entirely free from water, and conform to the following additional requirements:

	Min.	Max.
Specific Gravity 15.5°/15.5°C .....	0.860	0.875
Residue after polymerization with 38 NH <sub>2</sub> SO <sub>4</sub> , volume, per cent .....		2.0
Consistency shall be viscous		
Color shall be straw or darker		
Initial boiling point at 760 mm. pressure, per cent .....	90	

The method of test shall be in accordance with A.S.T.M. Serial Designation D 233-36.

(b) Drier: This material shall be a resin free drier, composed of lead, manganese or cobalt, or a mixture of any of these elements combined with a suitable fatty oil and mineral spirits or turpentine, or a mixture of these solvents. It shall be reasonably free from sediment and suspended matter and shall otherwise conform to the following:

Appearance—Clear.

Color—A mixture with linseed oil (1:8) shall not be darker than a solution of 3 grams of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in 100 cc H<sub>2</sub>SO<sub>4</sub> (1.84).

Flash Point—Not lower than 30°C. (86°F.) (Tag. closed cup).

Non-Volatile Matter—Not more than 30 per cent by weight.

(c) 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.

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(d) Lamp Black: This material shall be the fully calcined product of oils or tars free from acid or grit. In addition it shall meet the following requirements:

Total Carbon, min., per cent .....	98
Benzol Extract (which must be colorless), max., per cent .....	0.5
Ash, max., per cent .....	1.0

CONSTRUCTION METHODS

4.06 General Requirements:

(a) Packing: Paint shall be delivered in containers not larger than 5 gallon capacity.

(b) Identification: Each 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.

(c) Analysis: A one quart sample shall be taken at random from any or all deliveries and acceptance or rejection of shipments will be based on the analysis of these samples. The contractor, should therefore, secure necessary paint in ample time so that no delay to work will be caused by the time necessarily used in testing for which twenty-one 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.

(e) Weather Conditions: Paint shall not be applied when the atmospheric temperature is below 40°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 in the open. 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) Protecting of Public and Work: The contractor shall protect pedestrian, vehicular and other traffic upon or underneath the bridge and also all portions of the bridge superstructure and substructure against damage or disfigurement by spatters, splashes and smirches of paint or paint materials.

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(g) **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.

(h) **Application:** Painting shall be done in a neat and workmanlike manner. Brushes preferably shall be round or oval in shape, but if flat brushes are used they shall not exceed 4 inches in width. The paint when applied shall be so manipulated under the brush as to produce a coating of uniform color and even thickness in close contact with the surface or with previously applied paint and shall be worked into all corners and crevices. On surfaces which are inaccessible to paint brushes, the paint shall be applied with sheepskin daubers specially constructed for the purpose. All surfaces coated with impure or unauthorized paint shall be thoroughly cleaned and repainted to the satisfaction of the engineer at the contractor's expense.

**4.07 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 two 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, scabs, fins, blisters or other surface deformations, shall be given the shop coat of paint.

The composition used for coating machine-finished surfaces

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shall be mixed in the following proportions: 4 pounds tallow, 2 pounds white lead and 1 quart linseed oil.

### 4.08 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 water-tight 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 two-ply tar paper wide enough to project three inches beyond the edges of the members. These edges shall be bent down at an angle of 45 degrees.

### 4.09 Painting of Timber and Other Surfaces:

Parts of timber structures, other than rails and rail posts, 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, two coats of field paint.

The color of the various coats of paint applied to timber

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structures, guard rails, etc., shall be of shades sufficiently different to permit detection of incomplete application.

### MEASUREMENT AND PAYMENT

#### 4.10 Method of Measurement:

No measurements will be made for painting, unless specifically provided for in the contract.

#### 4.11 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

### CLEANING, SCRAPING AND PAINTING STRUCTURAL STEEL

#### 5.01 Description:

This item shall consist of the cleaning, scraping and painting of structural steel in existing bridges.

#### MATERIALS

#### 5.02 Paint:

Paint used on this work shall conform to the requirements of "Painting" of these specifications.

#### CONSTRUCTION METHODS

#### 5.03 General:

Surfaces of metal to be repainted shall be cleaned thoroughly, removing rust, old paint, dirt, oil, grease and other foreign substance. Cleaning shall be done by means 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. Cleaning of metal shall be continued until, in the opinion of the engineer, the condition is satisfactory for the application of paint.

The composition and application of the paint shall conform to the requirements of "Painting" of these specifications.



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Structural steel surfaces to be repainted shall be given three coats of paint as follows:

1. First coat—Red lead paint
2. Second coat—Red lead paint, tinted with 1 ounce of lamp black, paste form, to 1 gallon of finished paint
3. Third coat—Aluminum paint

Alternate coats for the second and third coats specified above may be used only when the written approval of the engineer has been obtained.

### MEASUREMENT AND PAYMENT

#### 5.04 Method of Measurement:

Cleaning, scraping and painting, where called for in the contract, will be measured on a lump basis, which shall include all work of this nature to be performed under the contract.

#### 5.05 Basis of Payment:

The item "Cleaning, Scraping and Painting Structural Steel," when included in the contract, shall be paid for on a lump sum basis, which price and payment shall constitute full compensation for all materials, labor, equipment and tools necessary to complete the item.

Payment will be made under:

Item 6-5-1, Cleaning, Scraping and Painting Structural Steel, per lump.

## 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 be the product of the distillation and refining of crude asphaltic petroleum. It shall be free from

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coal tar pitch or any of its derivatives and shall conform to the following requirements:

	Min.	Max.
1. Flash Point C.O.C. °F. ....	392	
2. Softening Point °F. ....	150	170
3. Penetration at 32°F., 200 g., 1 min. ....	10	
77°F., 100 g., 5 sec. ....	25	50
115°F., 50 g., 5 sec. ....		100
4. Loss on heating at 325°F., 50 gms., 5 hrs.		1.0
5. Penetration of residue after heating at 77°F., 100 gms., 5 sec. as compared to penetration before heating, per cent....	80	
6. Ductility at 77°F., 5 cm., per min. ....	10	
At 40°F., 1 cm., per min. ....	4	
7. Total bitumen (soluble in carbon disul- phide), per cent .....	99.5	

6.03 Pitch:

Waterproofing pitch shall be a straight run coal tar pitch derived entirely from high temperature coal tar and shall conform to the following requirements:

	Min.	Max.
1. Water, per cent .....		0.0
2. Specific Gravity at 77°/77°F. ....	1.22	1.34
3. Softening Point (cube in Water Method)		
°F. (a) .....	130	140
(b) .....	140	150
4. Total bitumen (soluble in carbon disul- phide), per cent (a).....	75	88
(b).....	73	85
5. Distillation test: Total distillate, per cent by weight to 572°F. ....	12.0	
Residue, per cent by weight.....	88.0	
6. Specific Gravity of total distillate to 572° F. at 100°F./77°F. ....		1.03
7. Ductility at 77°F., 5 cm. per min., cm...	50	

Note: Pitch with a softening point at 130°-140°F. should generally be used on flat surfaces. Pitch with a softening point at 140°-150°F. should generally be used on vertical surfaces or on all surfaces of small structures.

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### 6.04 Fabric:

The waterproofing fabric shall be a woven cotton fabric having a thread count of not less than 18 and not more than 26 per inch, both in the warp and in the filling. No selvage shall be wider than  $\frac{1}{4}$  inch. Before being delivered on the work, it shall have been thoroughly saturated with an asphalt or tar meeting all requirements for waterproofing asphalt or tar as specified above, and of the same manufacture as that with which it is to be applied. The saturation shall be obtained without the use of bitumen solvents, and the process shall be such that every thread shall be both coated and saturated. The meshes of the fabric shall not be closed or sealed by the process of saturation; there shall be sufficient porosity maintained to allow successive moppings to seep through. The average weight of the treated fabric shall be not less than two and a half nor more than three times the weight of the untreated fabric.

The tensile strength of the treated fabric shall be not less than 50 pounds per inch of width and the elongation at rupture shall be not less than 10 per cent, both in warp and in the filling. The tensile strength and elongation shall be determined by the Grab Test as specified in the Standard Methods of Testing Cotton Fabrics, Designation D 39-38, of the A.S.T.M.

The finished fabric shall not be coated with talc, Portland cement, or other substances which would tend to prevent adhesion between successive plies.

### CONSTRUCTION METHODS

#### 6.05 General:

All surfaces must be reasonably smooth, without projection or holes which might cause puncturing of the membrane. They shall be reasonably dry and shall be swept clean of dust and all loose material before the application of the waterproofing. No work shall be done in freezing weather without written authorization from the engineer.

The surface to be waterproofed shall be given one coat of a suitable primer of the same manufacture as the other waterproofing materials. The waterproofing shall then be started at the low point and the sheets so laid that the drainage will be over and not against or along the laps. Before the placing of each sheet of fabric the surface to be covered by the sheet

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shall be swabbed with hot asphalt, the fabric immediately placed and swabbed with hot asphalt until the sheet lies flat against the surface free from ridges and entrapped air. The fabric shall be "shingled" so that at all points there will be two thicknesses and all edge laps shall be at least 4 inches and all end laps at least 12 inches. Under no circumstances shall one ply of fabric touch another at any point or touch the surface of the concrete as there must be at least three complete and unbroken moppings of asphalt. All corners and angles shall be waterproofed without cutting or slitting the fabric. Flashing shall be carefully done around all openings and obstructions in a manner meeting the approval of the engineer. At curbs, spandrel walls, etc., the flashings shall be done with separate sheets lapping the main membrane not less than 12 inches. All expansion joints and cracks in the concrete surfaces shall be covered with specially designed flashing.

### MEASUREMENT AND PAYMENT

#### 6.06 Method of Measurement:

The yardage to be paid for shall be the number of square yards of waterproofing measured in place in the completed and accepted work.

#### 6.07 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 6-6-1, 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.

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MATERIALS

7.02 Tar for Absorptive Treatment:

Tar for absorptive treatment shall be a liquid water gas tar which conforms to the following requirements:

	Min.	Max.
Specific Gravity 77°/77°F. ....	1.030	1.100
Specific Viscosity at 104°F., Engler.....		3.0
Total Distillate, per cent by weight, to 572°F.		50
Bitumen (soluble in carbon disulphide), per cent .....	98	
Water, per cent .....		3.0

7.03 Tar Seal Coat for Absorptive Treatment:

Tar seal coat for absorptive treatment shall conform to the following requirements:

	Min.	Max.
Specific Gravity at 77°/77°F. ....	1.090	1.190
Specific Viscosity at 104°F., Engler.....	8.0	20.0
Total distillate, by weight		
To 338°F. ....	2.0	8.0
To 455°F. ....	8.0	20.0
To 518°F. ....	16.0	28.0
To 572°F. ....		36.0
Softening Point of residue °F. ....		149
Bitumen (soluble in carbon disulphide), per cent .....	80	
Water, per cent .....		2.0

CONSTRUCTION METHODS

7.04 General:

After the concrete is cured in conformity with the requirements hereinbefore given in the specifications for "Concrete," the surfaces to be dampproofed shall be allowed to dry at least 10 days. They shall be then coated thoroughly with four coats of water gas tar, applied cold with a brush or spray gun, and each coat shall be absorbed before the succeeding one is applied. After absorption of the final coat, a seal coat of refined tar shall be applied at a temperature of about 80°F., and thoroughly brushed into all surfaces. 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.

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MEASUREMENT AND PAYMENT

**7.05 Method of Measurement:**

The yardage to be paid for shall be the actual number of square yards of surface dampproofed, measured in place in the completed structure and accepted.

**7.06 Basis of Payment:**

The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "damp-proofing," which price and payment shall be full compensation for furnishing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 6-7-1, Dampproofing, per square yard.

**SECTION 8**

**MOVABLE BRIDGE MACHINERY**

**POWER PLANT**

**OPERATING HOUSE**

**8.01 Description:**

These items shall consist of the design, construction and installation of movable bridge machinery, power plant or operating house.

**8.02 Materials:**

All materials shall conform to the requirements of Division IV.

**8.03 Construction Methods:**

The design, construction and installation of movable bridge machinery, power plant and operating house shall conform to the requirements of Division IV.

**8.04 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, rack and track, bearing discs, balance wheels, trunnions, pins, trunnion bearings, sleeves, tower sheaves, counterweight ropes and fittings, bolts, screws, bolt and nuts connecting machin-

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ery parts to structural steel, steel castings which form an integral part of the machinery, hand-operated roadway traffic gates, oil burning navigation lights, mechanically operated position indicators, and all other parts and fittings necessary for the satisfactory operation of the bridge.

(b) Power Plant: Power plants will be measured by the lump and the measurement shall include all operating gear, lock and miscellaneous electrical motors; internal combustion engines with all incidental parts; electrical generator sets; mechanical or solenoid brakes as specified; service control desk, with all instruments and indicators; controller; resistances; limit switches; switch boards; transformers; circuit breakers; navigation signals and sirens; storage batteries; battery chargers; Selsyn indicators; electrically operated position indicators; service lighting; traffic signals, gates and flashing red lights; spot light; conduits and wiring; submarine cables; flexible cables; instructors; spare parts; pit pump, complete; and all other items and equipment required for the installation of a complete power plant.

(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 table and chair. If the house is supported on piling, the piling will be measured as provided under "Bearing Piles," Section 1, Part 6, Division II.

**8.05 Basis of Payment:**

Machinery, power plant and operating house, measured as provided above, shall be paid for at the contract prices per lump for "Movable Bridge Machinery," "Power Plant" and "Operating House," as the case may be, which prices and payments 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.

Payment will be made under:

- Item 6-8-1, Movable Bridge Machinery, per lump.
- Item 6-8-2, Power Plant, per lump.
- Item 6-8-3, Operating House, per lump.

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SECTION 9

SOIL LOADING TEST

9.01 Description:

This item shall consist of the loading of foundation soil at the bridge site for the purpose of determining its safe bearing value.

9.02 Proportioning and Mixing:

All concrete shall be class "A," proportioned and mixed as set out under "Concrete."

MATERIALS

9.03 Testing Block:

Materials used in constructing the testing block shall conform to the requirements of the specifications for "Concrete."

CONSTRUCTION METHODS

9.04 General:

A block of concrete, measuring 3 feet by 3 feet by 1 foot 6 inches, shall be cast on a carefully prepared surface at the elevation of the proposed footing and within the area of the proposed permanent footing.

The method of supporting the test load shall be determined by the contractor and drawings covering same submitted to the engineer for his approval before starting the test. The loading platform or box shall be so constructed as to carry safely, in the opinion of the engineer, an amount of approved material equal in weight to twice the unit loading shown on the plans for each square foot of area of the concrete block.

The loading material shall be applied gradually, without causing vibration, and shall be so placed that the load will at all times be concentric with the testing block.

The bearing value of any soil so tested shall be considered equal to  $\frac{1}{2}$  of the load carried by the block without exceeding a total permanent displacement of  $\frac{1}{4}$  inch in forty-eight hours, excluding initial settlement. The application of load to the test area until the area fails or until twice the design load has been sustained without failure shall constitute one loading.

The test hole shall be kept thoroughly dry from the time it is opened until the loading test has been completed.



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### MEASUREMENT AND PAYMENT

#### 9.05 Method of Measurement:

Soil loading tests will be measured by the test and the number of tests completed shall be counted. No measurement of structural excavation will be made under this item.

#### 9.06 Basis of Payment:

The number of load tests completed and accepted, measured as provided above, shall be paid for at the contract price each for "Soil Loading Tests," which price and payment shall constitute full compensation for furnishing all materials, tools, labor, equipment and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 6-9-1, Soil Loading Tests, per test.

## SECTION 10

### APPROACH SLABS

#### 10.01 Description:

This item shall consist of the construction of concrete approach slabs for bridges or culverts, at the location and of the dimensions shown on the plans.

### MATERIALS

#### 10.02 Concrete:

Concrete for approach slabs shall be class "A." However, when the contract includes Portland cement concrete pavement, the contractor will be permitted to substitute the type of coarse aggregate which is being used in the concrete for pavement. When aggregate larger than the size specified for class "A" concrete is to be used, the ratio of fine to coarse aggregate shall be varied, as directed by the engineer, but in no case shall the cement content be less than 6 bags to each cubic yard of concrete.

Materials entering into the concrete used shall conform to the requirements of the specifications for "Concrete" or "Portland Cement Concrete Pavement" as the case may be.

#### 10.03 Reinforcing Steel:

Reinforcing steel shall be deformed bars of new billet steel and shall comply with the specifications for this type of steel under "Reinforcing Steel."

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### CONSTRUCTION METHODS

#### 10.04 General:

Approach slabs preferably shall not be poured until the pavement has been laid up to the beginning of approach slab exceptions. All concrete and reinforcing steel work shall be performed in accordance with the specifications for "Concrete" and "Reinforcing Steel."

#### 10.05 Roadway Finish:

The roadway finish shall be the same as that specified for bridge floors.

#### 10.06 Mud Pump Connections:

Mud pump connections shall be fabricated in accordance with the dimensions shown on the plans. In the event a metal cap is not provided, contractor shall fill each connection with firmly packed earth to within two inches from top, then fill remainder of hole with bituminous material.

### MEASUREMENT AND PAYMENT

#### 10.07 Method of Measurement:

Concrete shall be measured on a cubic yard basis as specified under "Concrete." Reinforcing steel shall be measured on a pound basis in accordance with the specifications for "Reinforcing Steel."

Mud pump connections will be measured as provided under "Portland Cement Concrete Pavement."

#### 10.08 Basis of Payment:

The quantities, measured as provided above, shall be paid for at the contract unit prices for "Concrete" and "Reinforcing Steel," which price and payment shall be full compensation for furnishing, hauling and placing all materials and for all labor, equipment, tools and incidentals required to complete the accepted work.

Mud pump connections will be paid for as provided under "Portland Cement Concrete Pavement."

## 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.

## DIVISION II—PART 6

### MATERIALS

#### 11.02 Barbed Wire:

Barbed wire shall be four point hog wire consisting of tough annealed strands heavily galvanized of the gauge 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 and dimensions shown on the plans.

#### 11.05 Posts:

Posts may be of creosoted or untreated timber and shall be of the dimensions indicated on the plans. They shall be straight and free from defects which will impair their life or materially reduce their strength and usefulness as fence posts. Unless otherwise shown on the plans, posts shall be sawed off square at both ends.

(a) Creosoted Posts: Creosoted posts shall be sawn halves from round posts which shall not be less than four and one-half inches in diameter at any point and shall be air or artificially seasoned yellow pine, impregnated by the full cell process as specified in Section 3, Part 6, Division II. The post shall retain not less than five pounds of grade 1 creosote oil per cubic foot of material.

(b) Untreated Posts: Untreated posts may be round posts or sawn square edge posts as indicated on the plans and may be black locus, cypress, catalpa, white oak or post oak. Cypress posts may be sound or pecky. Round posts shall be peeled and trimmed of all knots and knobs. The ground end of untreated posts shall be dipped in hot tar pitch, which coating shall extend to a point one-half foot above the ground line.

#### 11.06 Braces:

The braces shall be of sound timber of the sizes and dimensions shown on the plans.

**CONSTRUCTION METHODS**

**11.07 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. The post holes shall be back-filled, with carefully selected material for the backfill, and thoroughly compacted by tamping. 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 1,000 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.

**11.08 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. The contractor shall take every possible precaution and care against damage in removing the 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.

**11.09 Fence Posts in Rebuilt Fence:**

New posts shall be used in rebuilding fence where indicated on the plans or directed by the engineer. The posts shall be installed in the rebuilt fence in the same manner as specified for new fence.

**MEASUREMENT AND PAYMENT**

**11.10 Method of Measurement:**

Measurement of Fence: Fence will be measured by the station (one hundred linear feet) and the quantity determined by measurement of 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.

**11.11 Basis of Payment:**

The number of stations of fence and number of posts completed and accepted, measured as provided above, shall be

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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 6-11-1, New Barbed Wire Fence, per station.
- Item 6-11-2, New Combination Mesh and Barbed Wire Fence, per station.
- Item 6-11-3, Rebuilt Fence, per station.
- Item 6-11-4, New Fence Posts, per post.

## SECTION 12

### GATES

#### 12.01 Description:

This item shall consist of the furnishing and construction of gates of the design and dimension shown on the plans and constructed in accordance with these specifications.

### MATERIALS

#### 12.02 Lumber and Posts:

All lumber and posts shall be No. 2 common cypress rough and shall be of the size and dimensions shown on the plans. No. 2 common will admit unsound knots and slight peck on both sides, shakes and other defects that will not prevent the use of the piece in its full length and width for common dimension use.

The bottom three feet of posts shall be dipped in hot tar pitch.

#### 12.03 Hardware:

Strap hinges, carriage bolts, washers, nails, staples, and well chain shall be standard quality of the size and dimensions shown on the plans and acceptable to the engineer.

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### CONSTRUCTION METHODS

#### 12.04 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. The post holes shall be backfilled, great care used to select suitable material for the backfill, and thoroughly compacted by tamping. 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 constructed in a workmanlike manner acceptable to the engineer.

### MEASUREMENT AND PAYMENT

#### 12.05 Method of Measurement:

Gates will be measured, complete in place, and each completed gate shall be counted.

#### 12.06 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 6-12-1, Single Swinging Walk Gates, per gate.

Item 6-12-2, Single Swinging Driveway Gates, per gate.

## SECTION 13

### GUARD RAIL

#### 13.01 Description:

This item shall consist of furnishing and installing guard rail of the type specified in conformity with the detail plans. The guard rail shall be erected at the points indicated on the plans or as designated by the engineer and shall be constructed in accordance with the plans and these specifications.

### MATERIALS

#### 13.02 Resiliflex Guard Rail:

(a) Rail Plates: Rail plates shall be made of Open Hearth semi-spring steel, properly tempered for toughness and high

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strength. They shall be blanked to proper shape before galvanizing. After galvanizing, rail plates shall have their ends formed for hinge-like connections and then securely electrically spot welded. The tensile strength of the steel from which the rail plates are produced shall be not less than 70,000 pounds per square inch. The rail plate shall be of the size and dimensions shown on the plans.

(b) Spring Supports: Spring supports shall be made of Open Hearth spring steel, properly tempered after forming. The tensile strength of the steel from which the spring supports are produced shall be not less than 70,000 pounds per square inch.

(c) Fastenings: Pins, bolts, washer plates and nuts shall be steel and shall be of the size and dimensions shown on the plans.

(d) Protective Coating: Rail plates and spring supports (unless given a shop coat at the factory) and all other metal parts of the guard rail including fastenings shall be galvanized by the hot dip method. They shall have a continuous coating of prime virgin spelter so applied that it will adhere firmly to surfaces of the metal. The rails, as well as the spring leaves, shall have a coating of not less than one and four-tenth ounces of zinc per square foot and the thickness of the coating shall be determined by its ability to withstand four immersions in a testing solution of copper sulphate without showing any trace of metallic copper on the metal. The first three immersions shall be for a period of one minute each, and the fourth immersion for a period of one-half minute.

Rail plates and spring supports given a shop coat at the factory in lieu of galvanizing shall be coated with one coat of red lead paint conforming to the requirements of Section 4, Part 6, Division II or one coat of primer composed of fifty-five per cent by weight of pigment and forty-five per cent by weight of vehicle. The pigment composition shall be six per cent lead sulphate, ten per cent zinc oxide, thirty-two per cent basic lead chromate, ten per cent of ninety-five per cent red lead, twenty-one per cent pure iron oxide ( $\text{Fe}_2\text{O}_3$ ), and twenty-one per cent silica and silicates. The vehicle shall be of the fast-drying, long oil varnish type. The non-volatile portion shall be a minimum of fifty-two per cent by weight of the total vehicle and shall consist of resins combined with drying

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oils in such manner as to impart a high degree of water resistance, adhesion, elasticity, and durability to the paint.

The plates and spring supports shall be clean at the time the coat is applied. The paint shall be thoroughly dry before loading and shipping by the manufacturer. If galvanized plates and spring supports are used, painting will not be required.

(e) Paint: Paint for the field coats shall conform to the requirements of Section 4, Part 6, Division II. Specific reference is made to articles 4.02 (b), 4.03 (a), 4.04 (b), 4.05 (a) and 4.05 (b).

### 13.03 Flexbeam Guard Rail:

(a) Rails: The corrugated rail shall be made of Open Hearth high carbon steel (0.85-1.05) having a tensile strength of not less than 100,000 pounds per square inch. The rails shall be of the size and dimensions shown on the plans.

(b) Fastenings: Bolts, washer plates, and nuts shall be steel and shall be of the design, type, and dimensions shown on the plans.

(c) End Wings: End wings shall be of the design shown on the plans.

(d) Protective Coating: The rails and end wings shall be galvanized or given a shop coat of paint and all other metal parts of the guard rail shall be galvanized, all in accordance with article 13.02 (d).

(e) Paint: Paint for the field coats shall conform to the requirements of Section 4, Part 6, Division II. Specific reference is made to articles 4.02 (b), 4.03 (a), 4.04 (b), 4.05 (a) and 4.05 (b).

### 13.04 Duraguard Guard Rail:

(a) Rail Plates: The rail plates shall be made of Open Hearth, 40-50 carbon steel having a tensile strength of not less than 70,000 pounds per square inch. They shall be of the size and dimensions shown on the plans.

(b) Brackets: Brackets shall be of the cushion type adapted to all general guard rail use, consisting of a single plate, which shall be made of open hearth 40-50 carbon steel, properly tempered after forming.

(c) Fastenings: Bolts, washer plates, and nuts shall be steel and shall be of the size and dimensions shown on the plans.

(d) Protective Coating: The rail plates and brackets shall



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be galvanized or given a shop coat of pain and all other metal parts of the guard rail shall be galvanized, all in accordance with article 13.02 (d).

(e) Paint: Paint for the field coats shall conform to the requirements of Section 4, Part 6, Division II. Specific reference is made to articles 4.02 (b), 4.03 (a), 4.04 (b), 4.05 (a) and 4.05 (b).

### 13.05 Posts and Braces:

Posts and braces shall conform to the requirements of Articles 14.01-14.08, inclusive, Section 14, Part 6, Division II.

## CONSTRUCTION METHODS

### 13.06 Erection:

The posts shall be set plumb and firm, spaced and set in the ground as shown on the plans and to the lines and grades given. Posts shall be located as directed by the engineer. The post holes shall be backfilled, care being taken to select suitable material for the backfill and same shall be thoroughly compacted by constant tamping during backfilling operations. Sufficient water shall be added in order to insure the desired compaction. Before final completion, the posts shall be accurately aligned and realigned as often as necessary until final acceptance.

### 13.07 Painting, Field Coats:

After erection, all metal parts of the guard rail on which the shop coat has become scratched or chipped shall be thoroughly cleaned and spot painted with white lead paint. The spot coat shall be allowed to dry at least twelve hours before applying field coats. After the spot coat is thoroughly dry, all metal parts of the guard rail shall be painted with two coats of white lead. Before applying paint to galvanized surfaces, same shall be slightly etched with a diluted solution of vinegar composed of one quart of vinegar and two gallons of water.

### 13.08 Rebuilt Guard Rail:

Where indicated on the plans or directed by the engineer, the contractor will be required to take down and rebuild the existing guard rail at the locations shown on the plans. The guard rail shall be rebuilt and repainted in the same manner as specified for new guard rail. The contractor shall take every possible precaution and care against damage in removing and rebuilding the guard rail.

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### MEASUREMENT AND PAYMENT

#### 13.09 Method of Measurement:

Guard rail will be measured by the linear foot and the length of guard rail to be measured shall be the overall length in linear feet, measured from center to center of end posts.

#### 13.10 Basis of Payment:

The number of linear feet of guard rail completed and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot of "Guard Rail," complete in place, which price and payment shall constitute full compensation for furnishing all materials, including posts and braces, (except new posts and braces installed in "Rebuilt Guard Rail," unless otherwise specified), equipment, tools, labor, and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

- Item 6-13-1, Resiliflex Guard Rail, per linear foot.
- Item 6-13-2, Flexbeam Guard Rail, per linear foot.
- Item 6-13-3, Duraguard Guard Rail, per linear foot.
- Item 6-13-4, Rebuilt Guard Rail, per linear foot.

## SECTION 14

### PRECAST CONCRETE GUARD RAIL POSTS AND BRACES

#### 14.01 Description:

This item shall consist of furnishing precast concrete posts and braces for guard rail; excavating and setting the posts at the locations indicated on the plans or as directed, and backfilling; preparing, assembling and installing thereon guard rail or removing existing posts and reinstalling guard rail as the case may be. All concrete posts and braces shall be of the design and size indicated on the plans for the type of guard rail for which they are intended.

#### 14.02 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.

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### MATERIALS

#### 14.03 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.

#### 14.04 Reinforcing Steel:

Reinforcing steel shall consist of deformed bars and shall conform to the requirements of Article 6.02, Part 4, Division II.

### CONSTRUCTION METHODS

#### 14.05 Casting:

The concrete posts and braces shall be cast in mortar tight forms. Special care shall be exercised to puddle and tamp the concrete around the reinforcing steel and to avoid the formation of stone pockets. Concrete shall be placed continuously in each post or brace.

#### 14.06 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 braces and the entire surface of the posts or brace brought to a smooth, neat appearance by rubbing off rough spots with a carborundum block.

#### 14.07 Curing:

As soon as finished the posts and braces shall be covered with three thicknesses of wet burlap and kept continuously moist for a period of seven days. No posts shall be set until at least two weeks old.

#### 14.08 Erection:

Rebuilt guard rail shall be erected in the same manner as provided for new guard rail.

### MEASUREMENT AND PAYMENT

#### 14.09 Method of Measurement:

Precast concrete guard rail posts and braces will be measured by the post or brace and the number of posts and braces installed shall be counted.

#### 14.10 Basis of Payment:

The number of precast concrete posts and braces installed and accepted, measured as provided above, shall be paid for

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at the contract unit price per each for "Precast Concrete Guard Rail Posts and Braces," complete in place, which price and payment shall constitute full compensation for furnishing all materials, tools, labor, equipment, and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 6-14-1, Precast Concrete Guard Rail Posts and Braces, per each. (Posts and braces counted separately.)

### SECTION 15

#### PROJECT MARKERS RIGHT OF WAY MARKERS

##### 15.01 Description:

This item shall consist of furnishing and erecting project markers, and right of way markers in conformity with the design, dimensions, and elevations shown on the plans.

##### 15.02 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

##### 15.03 Cement, Sand, Coarse Aggregate and Water:

These materials shall meet the requirement of Section 5, Part 4, Division II. Specific reference is made to Articles 5.03 to 5.07, inclusive.

##### 15.04 Reinforcing Steel:

Reinforcing steel shall consist of deformed bars and shall conform to the requirements of Article 6.02, Part 4, Division II.

##### 15.05 Marker Plates:

Marker plates shall be of the material shown on the plans.

(a) Cast Iron: Cast iron marker plates shall be gray cast iron true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other imperfections.

(b) Bronze: The bronze shall contain not less than eighty-five per cent copper and shall be true to pattern in form and dimensions.

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### 15.06 Paint:

Paint shall conform to the requirements of Section 4, Part 6, Division II.

## CONSTRUCTION METHODS

### 15.07 Project Markers:

The markers shall consist of either cast iron or bronze plates as indicated on the plans.

(a) Cast Iron Markers: The required number of cast iron marker plates shall be furnished and installed on reinforced concrete posts at the locations indicated on the plans or as directed by the engineer. The concrete posts shall be cast, finished and cured in accordance with Articles 14.05, 14.06 and 14.07, respectively, Part 6, Division II. The plate shall be painted with two coats of black graphite paint and the faces of the raised letters shall be painted with two coats of white lead and oil.

(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.

### 15.08 Right of Way Markers:

These 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 posts shall be cast, finished, and cured in accordance with Articles 14.05, 14.06 and 14.07, respectively, Part 6, Division II.

(b) Bronze Markers: These markers shall conform to the requirements of Article 15.07 (b).

### 15.09 Backfilling:

All posts shall be set to the depth indicated on the plans or as directed by the engineer and post holes shall be back-filled with selected suitable material. The backfill shall be placed in layers, watered and tamped as directed by the engineer.

## MEASUREMENT AND PAYMENT

### 15.10 Method of Measurement:

Project and right of way markers will be measured by the marker and the number placed and accepted shall be counted.

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### 15.11 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 6-15-1, Project Markers (Cast Iron), per marker.

Item 6-15-2, Project Markers (Bronze), per marker.

Item 6-15-3, Right of Way Markers (Concrete Posts), per marker.

Item 6-15-4, Right of Way Markers (Bronze), per marker.

## SECTION 16

### UNDERDRAINS

#### 16.01 Description:

This item shall consist of underdrains of the kinds and sizes designated on the plans or by the engineer, constructed in accordance with these specifications and conforming to the lines, grades, dimensions and designs shown on the plans or directed by the engineer.

### MATERIALS

#### 16.02 Perforated Corrugated Metal Pipe Culvert:

(a) Material Covered: These specifications cover perforated corrugated metal pipe for use in the construction of underdrains.

(b) Requirements: Perforated corrugated metal pipe shall conform to the requirements of the A. A. S. H. O., Standard Specifications for Perforated Corrugated Metal Pipe, Specification M-36.

(c) Sampling and Testing: Sampling and testing shall be done in accordance with the A. A. S. H. O. Specification M-36.

#### 16.03 Drain Tile:

(a) Material Covered: These specifications cover concrete or clay drain tile for use in the construction of pipe underdrains.

(b) Requirements: All drain tile shall conform to the requirements of the A. S. T. M. Standard Specifications for Drain Tile, Serial Designation C 4-24.

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(c) Sampling and Testing: Sampling and testing shall be done in accordance with the methods prescribed in the A. S. T. M. Standard Specifications for Drain Tile, Serial Designation C 4-24.

**16.04 Stone or Gravel Backfill Material:**

Unless otherwise shown on the plans or in the special provisions, the backfill shall consist of hard, durable particles of stone or gravel uniformly graded in size as follows:

Passing a 2½ inch screen, per cent.....	100
Passing a ½ inch screen, max., per cent.....	5

CONSTRUCTION METHODS

**16.05 Installation:**

Trenches shall be carefully excavated to the depth required to permit the pipe or tile to be laid to the grade desired. The pipe or tile shall be bedded firmly in the trench and the ends shall be closely joined and set to true alignment. Perforated pipe shall be laid with the perforated side down.

After pipe or tile has been laid and approved, it shall be covered with the backfill material specified on the plans or in the special provisions, care being taken in placing backfill material so as to prevent displacement or breakage of the tile. Earth backfill shall be of suitable material tamped in place in layers not to exceed six inches. Lateral connections to the drain shall be made as directed. Headers or caps for the pipe or tile when required shall be furnished and installed by the contractor. The outlet end of each underdrain shall be carefully installed as directed by the engineer.

MEASUREMENT AND PAYMENT

**16.06. Method of Measurement:**

Underdrains will be measured by the linear foot and the number of linear feet of underdrains actually completed will be measured.

**16.07 Basis of Payment:**

The number of linear feet of underdrains completed and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot of "Underdrains," which price and payment shall constitute full compensation for all necessary excavation and backfilling; for furnishing all materials, including stone or gravel backfill, equipment, tools, labor, and incidentals and the performance of all work necessary to complete the item.

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Payment will be made under:

- Item 6-16-1, Eight Inch Perforated Corrugated Metal Pipe Underdrains, per linear foot.
- Item 6-16-2, Ten Inch Perforated Corrugated Metal Pipe Underdrains, per linear foot.
- Item 6-16-3, Twelve Inch Perforated Corrugated Metal Pipe Underdrains, per linear foot.
- Item 6-16-4, Four Inch Drain Tile (Farm), per linear foot.
- Item 6-16-5, Five Inch Drain Tile (Farm), per linear foot.
- Item 6-16-6, Six Inch Drain Tile (Farm), per linear foot.
- Item 6-16-7, Eight Inch Drain Tile (Farm), per linear foot.
- Item 6-16-8, Ten Inch Drain Tile (Farm), per linear foot.
- Item 6-16-9, Twelve Inch Drain Tile (Farm), per linear foot.
- Item 6-16-10, Four Inch Drain Tile (Standard), per linear foot.
- Item 6-16-11, Five Inch Drain Tile (Standard), per linear foot.
- Item 6-16-12, Six Inch Drain Tile (Standard), per linear foot.
- Item 6-16-13, Eight Inch Drain Tile (Standard), per linear foot.
- Item 6-16-14, Ten Inch Drain Tile (Standard), per linear foot.
- Item 6-16-15, Twelve Inch Drain Tile (Standard), per linear foot.
- Item 6-16-16, Four Inch Drain Tile (Extra Quality), per linear foot.
- Item 6-16-17, Five Inch Drain Tile (Extra Quality), per linear foot.
- Item 6-16-18, Six Inch Drain Tile (Extra Quality), per linear foot.
- Item 6-16-19, Eight Inch Drain Tile (Extra Quality), per linear foot.
- Item 6-16-20, Ten Inch Drain Tile (Extra Quality), per linear foot.
- Item 6-16-21, Twelve Inch Drain Tile (Extra Quality), per linear foot.



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**SECTION 17**

**DITCH CHECKS**

**17.01 Description:**

This item shall consist of the construction of ditch checks in conformity with the plans and these specifications at the locations indicated on the plans or as directed by the engineer.

**MATERIALS**

**17.02 Lumber:**

Pecky cypress lumber shall be free from excess peck and of sufficient strength to withstand driving where required.

**CONSTRUCTION METHODS**

**17.03 Erection:**

Timber ditch checks shall be carefully framed and erected as designated on the plans. Vertical timbers may be driven where it is possible to do so without damage to the timber. Where this procedure is not possible, the contractor will be required to set ditch checks and all material used for back-filling shall be thoroughly tamped.

**MEASUREMENT AND PAYMENT**

**17.04 Method of Measurement:**

Ditch checks will be measured by the thousand feet board measure.

**17.05 Basis of Payment:**

The number of thousand feet board measure placed and accepted, measured as provided above, shall be paid for at the contract unit price per thousand feet board measure, for "Ditch Checks," complete in place, which price and payment shall constitute full compensation for all excavation and back-filling; for all materials, including hardware, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

Payment will be made under:

Item 6-17-1, Ditch Checks, per thousand feet board measure.

## 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 one-fourth of a cubic foot.

If suitable material is available, stone for riprap may be obtained from 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

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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 hand tamping or other 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 stones 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 six 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 stone 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, three 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

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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 6-18-1, Random Riprap, per cubic yard.
- Item 6-18-2, Hand-Placed Riprap, per square yard.
- Item 6-18-3, Grouted Riprap, per square yard.

### SECTION 19

#### REVETMENTS

- Concrete Block Revetments
- Grouted Concrete Block Revetments
- Sand Cement Revetments

##### 19.01 Description:

This item shall consist of the construction of revetments composed of 4" x 12" x 24" precast concrete blocks or of sand and cement, mixed dry, and placed in cement sacks, which shall be placed against the embankment to be protected in accordance with the plans and these specifications or as directed by the engineer.

##### 19.02 Proportioning and Mixing:

Concrete Block: All concrete for this item shall be class "D," proportioned and mixed as set out under Section 5, Part 4, Division II.

Sand Cement: The sand and cement shall be mixed dry, in proportion of one part cement to five parts sand, until the mixture is of uniform color.

#### 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.

#### CONSTRUCTION METHODS

##### 19.04 Placing:

Concrete Block Revetment: Unless otherwise directed, the slopes upon which concrete block is to be placed shall conform to the slope of the cross section of the embankment as shown

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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.

**Grouted Concrete Block Revetment:** When designated on the plans or in the contract, revetment constructed of concrete blocks shall be grouted into place. Grout shall be applied in such a manner as to insure filling all joints and crevices.

**Sand Cement Revetment:** Unless otherwise directed, the slopes upon which sand cement sacks are to be placed shall conform to the slope of the cross section of the embankment as shown on the plans.

The sacks shall be filled approximately two-thirds full, and shall be securely and substantially tied. The placing of sacks shall commence in a trench below the toe of the slope and shall progress upward. The tied ends of sacks shall all be pointed downward toward the toe of the slope. The sacks shall be rammed or packed against each other so as to form a close and moulded contact after the cement and sand mixture has set up. Sacks ripped or otherwise damaged in placing shall be removed and replaced with sound, unbroken sacks. All sacks shall be thoroughly wetted by sprinkling with water as soon as practicable after placing.

### MEASUREMENT AND PAYMENT

#### 19.05 Method of Measurement:

**Concrete Block and 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.

**Sand Cement Revetment:** Sand cement revetment will be measured by the cubic yard and the number of cubic yards determined by counting the number of sacks placed and accepted. Forty sacks will be considered to equal one cubic yard of revetment.

#### 19.06 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 con-

stitute 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 6-19-1, Concrete Block Revetments, per square yard.
- Item 6-19-2, Grouted Concrete Block Revetments, per square yard.
- Item 6-19-3, Sand Cement Revetments, per cubic yard.

## SECTION 20

### CONCRETE CURB AND GUTTERS

- Plain Concrete Curb
- Plain Concrete Gutter
- Combination Curb and Gutter
- Combination Lip Curb and Gutter
- Integral Concrete Curb
- Integral Concrete Lip 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.

#### 20.02 Proportioning and Mixing:

Integral Types: All concrete for these items shall be the same as provided for the roadway slab of which it shall form an integral part and proportioned and mixed as set out in Section 4, Part 3, Division II.

All Types Except Integral: All concrete for these items shall be class "A," proportioned and mixed as set out under Section 5, Part 4, Division II.

### MATERIALS

#### 20.03 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 Article 5.03 to 5.08, inclusive.

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### CONSTRUCTION METHODS

#### 20.04 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 underdrain is to be placed under curbing and gutter, the excavation and back-filling for same shall be completed and compacted before subgrade for curbing and gutter is prepared.

#### 20.05 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 three stakes shall be provided for each ten feet. Wood forms shall be minimum two inch SIS plank. 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.

#### 20.06 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-fourth inch joints shall be provided at intervals of six feet, unless otherwise indicated on the plans, except where shorter sections are necessary for closures. The separation shall be effected by using steel plates one-fourth inch in thickness, cut to true section, and set ver-

tically in the forms until the concrete has set sufficiently to permit withdrawal of the plates.

**20.07 Depositing 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 thirty 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.

**20.08 Finishing:**

The forms shall be removed within twenty-four hours after the concrete has been placed and honeycombed places 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.

**20.09 Curing:**

After finishing, the curb or gutter shall be cured in the same manner as provided for Portland Cement Concrete Pavement.

**20.10 Backfilling:**

After the concrete has set sufficiently, the contractor shall backfill adjacent to the curb or gutter with suitable material



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which shall be tamped in layers of not more than six inches until firm and solid.

### MEASUREMENT AND PAYMENT

#### 20.11 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.

#### 20.12 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 6-20-1, Plain Concrete Curb, per linear foot.

Item 6-20-2, Plain Concrete Gutter, per square yard.

Item 6-20-3, Combination Curb and Gutter, per linear foot.

Item 6-20-4, Combination Lip Curb and Gutter, per linear foot.

Item 6-20-5, Integral Concrete Curb, per linear foot.

Item 6-20-6, Integral Concrete Lip Curb, per linear foot.

## SECTION 21

### RESETTING CURB AND COMBINATION CURB AND GUTTER

#### 21.01 Description:

This item shall consist of resetting curb or combination curb and gutter in accordance with the plans and these specifications or as directed by the engineer.

### CONSTRUCTION METHODS

#### 21.02 General:

When required by the plans or special provisions of the contract, existing curb or combination curb and gutter approved by the engineer for reuse shall be reset. The existing

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curb or combination curb and gutter shall be removed from its original position, cleaned and reset in the new location in a satisfactory manner upon the prepared subgrade. The curb or combination curb and gutter shall be set accurately to the line and grade given by the engineer. Where unsatisfactory material is encountered in the preparation of the subgrade, it shall be removed and replaced with suitable material which shall be compacted by tamping in layers of not more than six inches in depth when in a loose condition. The entire subgrade shall be thoroughly compacted by rolling or tamping. If the subgrade material is too dry to compact to the satisfaction of the engineer, it shall be wetted with water as directed by the engineer. After the curb or combination curb and gutter has been reset the space behind the curb shall be backfilled to the required elevation with suitable material which shall be tamped firm and neatly graded.

### MEASUREMENT AND PAYMENT

#### 21.03 Method of Measurement:

Curb or combination curb and gutter reset will be measured by the linear foot. Reset curb or combination curb and gutter will be measured 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 reset.

#### 21.04 Basis of Payment:

All curb or combination curb and gutter reset, completed and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot for "Reset Curb" or "Reset Combination Curb and Gutter," which price and payment shall constitute full compensation for removing, cleaning and resetting the curb or combination curb and gutter, as the case may be, the preparation of the subgrade, 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 6-21-1, Reset Curb, per linear foot.

Item 6-21-2, Reset Combination Curb and Gutter, per linear foot.

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**SECTION 22**

**CATCH BASINS, MANHOLES, INLETS AND PIPE  
JUNCTIONS**

**22.01 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.

**22.02 Proportioning and Mixing:**

(a) Concrete: All concrete for this item shall be class "A," proportioned and mixed as set out under Section 5, Part 4, Division II.

(b) Mortar: All mortar for this item shall be composed of one part cement and two parts of sand by volume. The cement and sand shall be thoroughly mixed and sufficient water added to produce a consistency of stiff paste.

**MATERIALS**

**22.03 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.

**22.04 Reinforcing Steel:**

Reinforcing steel shall consist of deformed bars and shall conform to the requirements of Article 6.02, Part 4, Division II.

**22.05 Brick:**

Brick shall conform to the requirements of, and shall be sampled and tested in accordance with, the A.S.T.M. Tentative Standard Specifications for Sewer Brick, Serial Designation C 32-37T. Unless otherwise specified on the plans or in the special provisions, brick shall conform to the requirements of grade MA and size No. 1.

**22.06 Gray Iron Castings:**

Gray iron castings shall meet the requirements for class No. 20 of the A.S.T.M. Standard Specifications for Gray Iron Castings, Serial Designation A 48-36, supplemented by the following:

The castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes

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and other defects in position affecting their strength and value for the service intended. Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. Surfaces of the castings shall be free from burnt on sand and shall be reasonably smooth. Runners, risers, fins, and other cast-on pieces shall be removed. 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

#### 22.07 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 one-half brick as nearly as practicable. The courses shall be level in all places except where otherwise necessary. At least one course in every seven 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

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kind shall be removed from the inside of the structures before final acceptance.

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 of not more than six inches in depth when in a loose condition and each layer thoroughly compacted by hand or 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 by the engineer.

### MEASUREMENT AND PAYMENT

#### 22.08 Method of Measurement:

Catch basins, manholes, inlets, pipe junctions and similar structures will be measured by the structure complete in place

#### 22.09 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, all excavation and backfilling, for furnishing all castings, metal frames, covers and gratings and all other fittings, and materials, 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 6-22-1, Catch Basins, Manholes, Inlets and Pipe Junctions, per each.
- Item 6-22-2, Catch Basins, per each.
- Item 6-22-3, Manholes, per each.
- Item 6-22-4, Inlets, per each.
- Item 6-22-5, Pipe Junctions, per each.

**SECTION 23****ADJUSTING CATCH BASINS, INLETS, MANHOLES AND  
PIPE JUNCTIONS****23.01 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****23.02 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 two parts sand, by volume, and thoroughly mixed to a uniform consistency of stiff paste. Adjoining courses shall break joints one-half brick as nearly as practicable. The courses shall be leveled in all places except where otherwise may be necessary for the proper adjustment of the structure. At least one course in every seven 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.

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Frames for castings and cast iron bearing plates shall be set in full mortar beds composed of one part Portland cement and two 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 of not more than six inches in depth when in a loose condition and each layer thoroughly compacted by hand or 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 by the engineer.

### MEASUREMENT AND PAYMENT

#### 23.03 Method of Measurement:

Catch basins, inlets, manholes and pipe junctions adjusted will be measured by the structure and each structure adjusted will be counted.

#### 23.04 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 6-23-1, Adjusting Catch Basins, Inlets, Pipe Junctions and Manholes, per each.
- Item 6-23-2, Adjusting Catch Basins, per each.
- Item 6-23-3, Adjusting Inlets, per each.
- Item 6-23-4, Adjusting Pipe Junctions, per each.
- Item 6-23-5, Adjusting Manholes, per each.

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**SECTION 24**

**PLAIN PORTLAND CEMENT CONCRETE WALKS,  
BUMPER STRIPS AND STEPS**

**24.01 Description:**

This item shall consist of the construction of concrete walks, bumper strips and steps in one course on the prepared subgrade in conformity with the lines, grades, thickness and cross sections as are 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.

**CONSTRUCTION METHODS**

**24.04 Subgrade:**

The subgrade shall be constructed as provided under subgrade in Article 4.12, Part I, 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 hand or mechanically tamped.

**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, bumper strips or steps to be constructed. Wood forms shall have a minimum thickness of two 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.



## DIVISION II--PART 6

### **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 one-fourth inch radius.

### **24.07 Joints:**

The walks and bumper strips 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 thirty-two feet and at all junctions of new walks with drives, curbs, buildings, structures and old walks and same filled with premoulded filler three-fourths of an inch thick.

### **24.08 Curing:**

The walks, bumper strips or steps shall be cured in the same manner as provided for concrete pavement.

### **24.09 Backfilling:**

After the concrete has set sufficiently, the forms shall be removed and the space adjacent to the walks, bumper strips or steps shall be backfilled with suitable material, which shall be firmly compacted and neatly graded.

## MEASUREMENT AND PAYMENT

### **24.10 Method of Measurement:**

Concrete walks, bumper strips and steps will be measured by the square yard. The area measured for steps will be that of the treads only.

### **24.11 Basis of Payment:**

The number of square yards, completed and accepted, measured as provided above, shall be paid for at the contract unit price per square yard for "Walks," "Bumper Strips" and "Steps," complete in place, which price and payment shall constitute full compensation for preparing the subgrade; furnishing all materials, and for furnishing all forms, equipment, tools, labor and incidentals and the performance of all work necessary to complete the item.

## DIVISION II—PART 6

Payment will be made under:

- Item 6-24-1, Portland Cement Concrete Walk, 4" thick, per square yard.
- Item 6-24-2, Portland Cement Concrete Walk, 5" thick, per square yard.
- Item 6-24-3, Portland Cement Concrete Walk, 6" thick, per square yard.
- Item 6-24-4, Portland Cement Concrete Walk, 7" thick, per square yard.
- Item 6-24-5, Portland Cement Concrete Walk, 8" thick, per square yard.
- Item 6-24-6, Portland Cement Concrete Bumper Strip, 4" thick, per square yard.
- Item 6-24-7, Portland Cement Concrete Bumper Strips, 5" thick, per square yard.
- Item 6-24-8, Portland Cement Concrete Bumper Strips, 6" thick, per square yard.
- Item 6-24-9, Portland Cement Concrete Bumper Strip, 7" thick, per square yard.
- Item 6-24-10, Portland Cement Concrete Bumper Strip, 8" thick, per square yard.
- Item 6-24-11, Portland Cement Concrete Steps, per square yard.

### SECTION 25

#### PULLING AND REDRIVING WELLS

##### 25.02 General:

This item shall consist of pulling pipe wells and redriving them at the location 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 pump in its new

## DIVISION II—PART 6

location shall be furnished by the contractor without additional compensation.

The contractor will be required to furnish a certificate of release from the property owner as specified in Article 31.02, Part 6, Division II.

### MEASUREMENT AND PAYMENT

#### 25.03 Method of Measurement:

Pulling and re-driving wells will be measured by the well and each well pulled and re-driven will be counted.

#### 25.04 Basis of Payment:

The number of wells pulled, re-driven 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 re-driving, 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 6-25-1, Pulling and Redriving Wells, per well.

## SECTION 26

### CONSTRUCTING WELLS

#### 26.01 Description:

This item shall consist of the construction of new wells at the location shown on the plans or as directed by the engineer to replace existing wells and the filling of the old wells, and shall be done in conformity with the plans and in accordance with these specifications.

### CONSTRUCTION METHODS

#### 26.02 General:

Wells shall be constructed the same size as the ones they replace and shall be lined or cased with material of the same type or character as the lining 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,

## DIVISION II—PART 6

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. The old wells shall be filled with material secured as "Excavation." The contractor will be required to furnish a certificate of release from the property owner as specified in Article 31.02, Part 6, Division II.

### 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. The filling of the old wells will be paid for as "Excavation."

Payment will be made under:

Item 6-26-1, Constructing Wells, per well.

## SECTION 27

### RAILROAD GRADE CROSSING

Steel Plate Railroad Grade Crossing

Creosoted Plank 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.

## DIVISION II—PART 6

### MATERIALS

#### 27.02 Steel Plate:

The traffic tread plates shall be rolled steel plates of the size and dimensions shown on the plans and shall weigh not less than 11.2 pounds per square foot. The plates shall have a diamond or other pattern tread acceptable to the engineer.

#### 27.03 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.

#### 27.04 Lumber:

All lumber, including cross-ties, shall be creosoted southern yellow pine, structural square edge and sound and shall conform to the requirements of Section 8, Part 4, Division II.

#### 27.05 Ballast:

Ballast shall conform to the requirements for Washed Sand Gravel, Article 2.05, Part 2, Division 11.

### CONSTRUCTION METHODS

#### 27.06 General:

The contractor shall give the Railroad Company at least five days advance written notice of commencement of any work whatever by the contractor on the premises of the Railroad Company in order that the Railroad Company may have on hand any representatives that they may see fit to have present. This work shall be so conducted as not to interfere with the movement of trains or other operations of the railroad. 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

#### 27.07 Method of Measurement:

Steel plate 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 steel plate.

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.

## DIVISION II—PART 6

### 27.08 Basis of Payment:

The number of square feet of grade crossings completed and accepted, measured as provided above, shall be paid for at the contract unit price per square foot 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 6-27-1, Steel Plate Railroad Grade Crossing, per square foot.

Item 6-27-2, Creosoted Plank Railroad Grade Crossing, per square foot.

## SECTION 28

### SALVAGED SURFACING MATERIAL

#### 28.01 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 of shoulders, or as directed, all in accordance with these specifications and at the locations shown on the plans.

### CONSTRUCTION METHODS

#### 28.02 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.

## DIVISION II—PART 6

### MEASUREMENT AND PAYMENT

#### 28.03 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.

#### 28.04 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 items.

Payment will be made under:

Item 6-28-1, Salvaged Surfacing Material, per cubic yard.

## SECTION 29

### REMOVAL OF BRIDGES AND CULVERTS

#### 29.01 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

#### 29.02 General:

No old structure shall be removed or closed to traffic until the 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. The work of disconnecting, removing, handling, hauling and piling of the members and

## DIVISION II—PART 6

parts shall be done by such methods and equipment that the steel will not be bent, distorted, or injured in any way. 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

#### 29.03 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.



## **DIVISION II—PART 6**

### **29.04 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, false work, labor and incidentals, and the performance of all work necessary to complete the item.

Payment will be made under:

- Item 6-29-1, Removal of Bridges, per structure.
- Item 6-29-2, Removal of Bridges, per each.
- Item 6-29-3, Removal of Culverts, per structure.
- Item 6-29-4, Removal of Culverts, per each.

## **SECTION 30**

### **REMOVING OLD PAVEMENT, CURB, CURB AND GUTTER, GUTTER AND WALKS**

#### **30.01 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**

#### **30.02 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. Suf-

## DIVISION II—PART 6

efficient 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

#### 30.03 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.

#### 30.04 Basis of Payment:

The number of square yards of old pavement, gutter or walk removed, and the number of linear feet of curb and 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 6-30-1, Removing Old Pavement, per square yard.
- Item 6-30-2, Removing Old Gutter, per square yard.
- Item 6-30-3, Removing Old Walk, per square yard.
- Item 6-30-4, Removing Old Curb, per linear foot.
- Item 6-30-5, Removing Old Combination Curb and Gutter, per linear foot.

## SECTION 31

### REMOVAL AND RELOCATION OF BUILDINGS AND MISCELLANEOUS STRUCTURES

#### 31.01 Description:

This item shall consist of the removal and relocation of buildings or structures of all types, together with all service connections, appurtenances and accessories; reconstructing all foundations and appurtenances, all in accordance with the plans and these specifications.

#### CONSTRUCTION METHODS

#### 31.02 General:

Buildings or structures shall be moved and placed in their new locations, as shown on the plans or as designated by the engineer, left plumb and level and in as good condition in all respects as they were before being moved. Buildings or structures moved shall be placed on foundations of the same type and character as those upon which they rested before being moved.

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 moved 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 replaced with foundations or appurtenances of the same size, type and character as existed before the building was moved.

Wherever sanitary sewers or water, gas, electric, or telephone service lines are connected to the buildings being moved, the same shall be disconnected, extended as necessary and reconnected 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, power houses, garages, and other outbuildings, cisterns, wells, septic tanks and other appurte-

## DIVISION II--PART 6

nances 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 location 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.

The moving of a building, any part of which is used as a filling station, unless otherwise noted on the plans, shall include the moving of all gasoline pumps, tanks, pipes, signs, and other accessories appurtenant to the filling station. Tanks shall be placed the same depth below the ground as existed before moving.

Material in the existing foundations, concrete or masonry floors, chimneys and other appurtenances, where not used in the reconstruction of the appurtenances, shall be removed and disposed of as directed by the engineer.

All new material required by the contractor in performing any of the above operations will be furnished by the contractor at his expense.

The contents of all buildings or structures shall be removed 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 placed 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 will not be required to move buildings or structures in excess of two hundred feet beyond the right of way line shown on the plans for all projects except grade separation projects (underpass and overpass structures) and for grade separation projects, the maximum distance beyond the right of way line shall be three hundred and fifty feet.

The contractor shall furnish the Commission 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.

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### MEASUREMENT AND PAYMENT

#### 31.03 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.

#### 31.04 Basis of Payment:

The number of buildings or structures removed and accepted, measured as provided above, shall be paid for at the contract price per unit for "Removal and Relocation 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 6-81-1, Removal and Relocation of Buildings and Miscellaneous Structures, per unit.

## SECTION 32

### PIPE HANDRAILING

#### 32.01 Description:

This item shall consist of furnishing, erecting and painting pipe handrailing of the size and style indicated on the plans and in accordance with these specifications.

### MATERIALS

#### 32.02 Black and Galvanized Steel Pipe:

Black and galvanized steel pipe shall be Standard Weight, conforming to the requirements of the Standard Specifications for Welded and Seamless Steel Pipe, A.S.T.M. Designation A 120-36.

#### 32.03 Wrought Iron Pipe:

Wrought iron pipe shall be Standard Weight, conforming to the requirements of the Standard Specifications for Welded Wrought Iron Pipe, A.S.T.M. Designation A 72-38.

## DIVISION II—PART 6

### 32.04 Fittings:

Fittings for pipe railings shall be of malleable iron and shall comply with the Standard Specifications for Malleable Iron Castings, A.S.T.M. Designation A 47-33. 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.

## CONSTRUCTION METHODS

### 32.05 Erection:

Shop drawings for rails must be submitted and approved before fabrication of rail is started.

Railing shall be constructed of the type specified, in accordance with details shown on the plans, and in conformity with the requirements herein. It shall be constructed to the alignment, grade, and camber as designated on plans.

Railing posts shall be erected vertically and the tops constructed on a level line or parallel to the grade as may be indicated on plans. Unless otherwise provided, railing shall not be placed until after the falsework for the span has been released. During the construction of railing, care shall be exercised to insure proper function of expansion joints. When expansion sleeves are called for, they shall be reamed to permit of free play in the direction of expansion.

If rails are to form a part of the superstructure, they shall be attached by the method shown on the drawings. Holes in flanged bases or other parts shall match holes in the structural metal and the contractor shall make all necessary arrangements to insure the proper agreement of the holes.

Posts having their lower ends embedded in concrete shall be set in holes previously prepared for the purpose and grouted with Portland cement mortar.

### 32.06 Painting:

Unless otherwise provided, all metal for railing not specified to be finished by galvanizing shall be given one shop coat and two field coats of paint as specified for steel structures, under "Painting," Section 4, Part 6, Division II.

## MEASUREMENT AND PAYMENT

### 32.07 Method of Measurement:

Pipe handrailing will be measured by the linear foot. The

## DIVISION II—PART 6

length for measurement shall be the actual length of pipe handrailing measured along the top rail from end to end.

### 32.08 Basis of Payment:

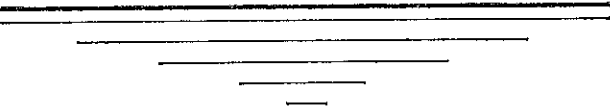
Pipe handrailing, placed and accepted, measured as provided above, shall be paid for at the contract unit price per linear foot for "Pipe Handrailing," complete in place, which price and payment shall constitute full compensation for furnishing all materials, erecting and painting the handrailing; all fittings, fillers, bolts, nuts and other parts necessary to attach the handrailing to the structure upon which it is to be erected; 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:

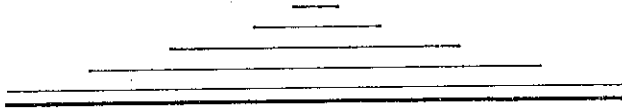
Item 6-32-1, Black Steel Pipe Handrailing, per linear foot.

Item 6-32-2, Galvanized Steel Pipe Handrailing, per linear foot.

Item 6-32-3, Wrought Iron Pipe Handrailing, per linear foot.



**DIVISION III**  
**DESIGN OF STRUCTURES**  
(Printed under separate cover.)





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**DIVISION IV**

**MOVABLE BRIDGES**

**Design and Construction**

**(Printed under separate cover.)**

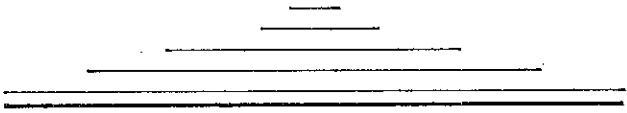
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# **DIVISION V**

## **CONTRACT DOCUMENTARY FORMS**



DIVISION V

LOUISIANA HIGHWAY COMMISSION

NOTICE TO CONTRACTORS

Sealed proposals for the construction of the following project will be received by the Louisiana Highway Commission,

....., Baton

Rouge, Louisiana, until.....

.....Proposals will not be received after

this hour. At.....of the same

day and date they will be publicly opened and read.....

.....

(Description of Project and other pertinent information to be placed here.)

Full information and proposal forms are available at the offices of the Highway Commission at Baton Rouge. Plans and specifications may be inspected at said office or will be

furnished upon payment of \$.....(not to be refunded.)

The Commission reserves the right to reject any and all proposals.

LOUISIANA HIGHWAY COMMISSION

..... CHAIRMAN

DIVISION V

LOUISIANA HIGHWAY COMMISSION  
CONSTRUCTION PROPOSAL

.....PROJECT NO.....

.....

Bids to be received up to....., 19...

by the Louisiana Highway Commission,.....

.....Baton Rouge, Louisiana. Bids will not be re-

ceived after this hour. At.....of the same day

and date, they will be publicly opened and read.....

.....

BID OF .....

ADDRESS .....

Date....., 19...

To the Louisiana Highway Commission,  
Baton Rouge, Louisiana.

Gentlemen:

I (We) hereby agree to perform all the work known and  
described by you as:

.....Project No.....

entitled .....

Route.... No....., Parish.....

consisting of.....miles of.....

....., located as follows:

(Description of location to be placed here.)

DIVISION V

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 Louisiana Highway Commission

....., together with the "Special Provisions," if any, attached to this proposal.

The plans herein referred to are the plans approved by the State Highway 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.

DIVISION V

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 Louisiana Highway Commission 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 State Highway 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 HIGHWAY COMMISSION". 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 checks of the two lowest bidders 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 Commission.

Respectfully submitted,

(If a Firm or Individual)

SIGNATURE OF BIDDER.....(Seal)

By:.....

.....

ADDRESS OF BIDDER.....

.....

*Handwritten marks and scribbles at the bottom of the page.*

DIVISION V

Names and Addresses of  
Members of the Firm

{ .....  
.....  
.....  
.....

(If a Corporation)

SIGNATURE OF BIDDER.....(Seal)..

By:.....

Names and Business  
Address of Officers

{ President.....  
.....  
Secretary.....  
.....  
Treasurer.....  
.....

Legal Domicile.....

Return Certified Check to:.....

.....

DIVISION V

LOUISIANA HIGHWAY COMMISSION  
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 Louisiana Highway Commission, acting by and  
through....., Chairman, the  
party of the First Part, and hereinafter designated as "Com-  
mission," and....., Contractor,  
domiciled and doing business in.....  
party of the Second Part, and hereinafter designated as "Con-  
tractor."

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 ma-  
terials, equipment and labor and perform the work required  
to build, construct and complete in a thorough and work-  
manlike manner, to the satisfaction of the State Highway

Engineer of the Louisiana Highway Commission,.....

.....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 Com-



DIVISION V

mission at Baton Rouge, Louisiana, dated.....  
....., and with the Standard Specifications for  
Roads and Bridges approved by the Louisiana Highway Com-  
mission....., and with  
the Proposal filed with the Commission 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 Commission 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 man-  
ner 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 8.07, Division I,  
of the Specifications.

Total cost of Item 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 Chairman of the Louisiana  
Highway Commission has hereunto subscribed his name, and  
the same has been duly attested by the Secretary of the  
Louisiana Highway Commission, and where and when the  
approval of the State Advisory Board is necessary hereto, the  
said Board has approved the same, and.....  
.....

DIVISION V

Contractor, has also hereunto subscribed his name on the days and dates set forth after their various signatures.

(If a Firm or Individual)

Names and Addresses of Members of the Firm ..... (Seal) Contractor

..... By:..... Title

..... On....., 19...

(If a Corporation)

Names of Officers ..... (Seal) Contractor

President

By:..... Title

Secretary

On....., 19...

Treasurer

Attest..... Secretary

Approved:

STATE ADVISORY BOARD

LOUISIANA HIGHWAY COMMISSION

By:..... By:..... Chairman

On....., 19... On....., 19...

Attest..... (Seal) Secretary

DIVISION V

LOUISIANA HIGHWAY COMMISSION  
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 Louisiana Highway Commission, and unto all sub-  
contractors, 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 con-  
tract to be observed, kept, done and performed, and each of  
them, at the time and in the manner and form therein

DIVISION V

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 Louisiana Highway Commission 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

..... (Seal) Attorney-in-fact

Countersigned

By:..... (Seal) Resident Agent

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