

P. F. Dancy

PROJECT No. _____

East Baton Rouge PARISH

LOUISIANA HIGHWAY COMMISSION

SPECIFICATIONS



NOTE: Complete Specifications for this Project are contained
in the following pamphlets: _____

The Contractor will be required to certify, when
contract is executed, that he has received each of
these pamphlets and is familiar with its contents.

LOUISIANA HIGHWAY COMMISSION

PAMPHLET "A"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

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SECTION 1. DEFINITION OF TERMS

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

- "STATE": State of Louisiana.
- "COMMISSION": Louisiana Highway Commission.
- "ENGINEER" or "STATE HIGHWAY ENGINEER": The State Highway Engineer, Louisiana Highway Commission.
- "RESIDENT ENGINEER": The representative of the State Highway Engineer, in direct charge of construction work.
- "INSPECTOR": An authorized representative of the Engineer, assigned to make necessary inspections of the work and materials.
- "LABORATORY": The official testing laboratories of the Commission or such other laboratories as may be designated by the Commission.
- "BIDDER": Any individual, firm or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.
- "CONTRACTOR": The individual, firm or corporation to whom the contract or work is awarded.
- "SURETY COMPANY": The corporate body which is bound with and for the Contractor, who is primarily liable, and which engages to be responsible for his payment of all debts pertaining to and for his acceptable performance of the work for which he has contracted.
- "PROPOSAL": The approved or prepared form on which the Bidder is to or has submitted his proposal for the work contemplated.
- "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 State and Parish, if the contract is awarded to him.
- "PRESIDENT POLICE JURY OF THE PARISH": Executive Head of the governing body of the Parish, authorized under the law to enter into contracts with the Louisiana Highway Commission.
- "GOVERNING BODY": Any Executive Body other than the Police Jury.
- "ROAD DISTRICT": Any Political Sub-division organized under the law for the purpose of permanent road construction.
- "PLANS": The official approved plans, profiles, typical cross section, general cross section, 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.
- "SPECIFICATIONS": The directions, provisions, and requirements contained herein 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. Special Provisions will govern the work and take precedence over the general specifications wherever in conflict therewith.

- "CONTRACT"**: The agreement between the Parties of the First and Second Part covering the performance of the work and the furnishing of materials in the construction of same. The Contract shall be mutually understood to include "Plans," "Specifications," "Special Provisions," "Notice to Contractors," "Proposals," and "Contract Bond," also any and all Supplemental Agreements which are required to complete the construction of the work.
- "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 the payment of all material or other obligations contracted by him in the prosecution thereof.
- "SPECIAL PROVISIONS"**: The specific clauses setting forth conditions, or requirements, peculiar to the project under consideration and covering work, or materials, involved in the proposal and estimate but not thoroughly or satisfactorily stipulated or set forth by the general specifications.
- "SUPPLEMENTAL AGREEMENT"**: A written agreement executed by the Commission and by the Contractor, with the assent of the Contractor's Surety, covering alterations and unforeseen work necessary to the project.
- "HIGHWAY"**: The whole right-of-way which is reserved for and secured for use in constructing the roadway and its appurtenances.
- "ROADWAY"**: That portion of the highway 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.
- "ROADBED"**: That portion of the roadway between the inside edges of slopes of ditches and tops of fill slopes; the "subgrade" plus the "shoulders."
- "SUBGRADE"**: That portion of the roadbed upon which the surface course or pavement is to be placed, except that for hard surfaced roads having a concrete base, the subgrade shall be interpreted to mean the area lying between points one (1) foot outside that portion on which the surfacing rests.
- "PAVEMENT"**: The combined base and surface courses, considered as a single unit, excluding shoulders, gutters and ditches.
- "SHOULDERS"**: That portion of the roadbed between the surfacing or pavement and the top of the side slopes of the roadbed.
- "STRUCTURES"**: As used in these Specifications shall mean 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.
- "BRIDGES"**: Structures of over 20-foot span measured under the copings along the center line of the road, and multiple span structures where the aggregate of the spans is in excess of 20 feet.
- "CULVERTS"**: All waterway structures not defined as bridges.
- "TEMPORARY STRUCTURES"**: Any temporary structures or stream crossing, required to maintain traffic while constructing or reconstructing structures or parts of structures covered by the contract. The temporary structure shall include the earth approaches thereto.

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- "BRIDGE COMPLETE": The entire structure, including both sub-structure and super-structure.
- "SUBSTRUCTURE": All of that part of the structure below the bridge seats or below the spring lines of concrete arches. Parapets, backwalls and wing-walls of abutments shall be considered as parts of the substructure.
- "SUPERSTRUCTURE": All of that part of the structure above the bridge seats or above the spring lines of concrete arches.
- "THE WORK": All the work specified herein or indicated on the plans as the contemplated improvement, covered by the Contract.
- "PROJECT NUMBER": A number used for convenience to describe and delineate certain construction within definite geographical limits and designates and includes both roadway and structures to be constructed and all that is necessary therefor within these limits.
- "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.
- "MATERIALS": Any substance proposed to be used in connection with the construction of any structure or the roadway and its appurtenances.
- "WORKING DAY": Except Sundays and legal holidays during which no work has been performed, any day, when the temperature, the weather or condition of the soil does not make it impossible for the Contractor to make effective use of at least seventy (70) per cent of the usual daily men hours during regular working hours.

(Approved by the Commission)

SECTION 2. PROPOSAL REQUIREMENTS AND CONDITIONS

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 or materials to be furnished, with a schedule of items for which unit bid 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.

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 in accordance with the plans and specifications, 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.

Examination of Plans, Specifications, Special Provisions, and Site of Work: The bidder is required to examine carefully the site of, and the proposal, plans, specifications and contract form for the work contemplated, and it will be assumed that he has judged for and satisfied himself as to the conditions to be encountered, as to the character, quality and quantities of work to be performed and materials to be furnished, and as to the requirements of these specifications, special provisions and contract.

Preparation of Proposal: The bidder must submit his proposal on the form above described, 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 figures), for which he proposes to do each item of the work contemplated, and shall also show the total sum based on the quantities shown. 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.

Rejection of Proposals Containing Alterations, Erasures or Irregularities: Proposals may be rejected if they show any alteration of form, additions not called for, conditional or alternate bids, incomplete bids, erasures, or irregularities of any kind.

Proposal Guaranty: Each bid must be accompanied by a certified check issued by a State or National bank in good standing and payable to the State Treasurer of

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Louisiana for five (5%) per cent of the correct gross amount of the bid. The number of working days, figured at twenty dollars (\$20.00) per day, is not to be included, when calculating the amount of certified check required.

Delivery of Proposals: Each proposal shall be placed, together with the proposal guaranty, in a sealed envelope so marked as to indicate its contents without being opened. This envelope shall then be placed in another which shall be sealed and addressed as indicated in the "Notice to Contractors." Proposals will be received on the hour and date set for the opening thereof and must be in the hands of the official indicated by that time. Proposals received after the time set for the opening will be returned to the bidder unopened.

Withdrawal of Proposals: A bidder may withdraw his proposal provided the request in writing is in the hands of the Secretary of the Highway Commission by the time set for opening proposals. When such proposal is reached, it will be returned to the bidder unread.

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

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 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. Proposals in which the prices obviously are unbalanced may be rejected. No contract will be awarded except to responsible bidders capable of performing the class of work contemplated.

Competency 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 on similar work, a list of machinery, plant organization and other equipment available for the proposed work, and such statements of their financial resources as may be deemed necessary, and shall be required to show that they have not failed to carry out all previous contracts with the State.

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

Consideration of Bids: For the purpose of award, after the proposals are opened and read, the correct summation of the products of the approximate quantities shown in the proposal, by the unit bid prices will, together with the number of working days figured at twenty dollars (\$20.00) per day, be considered the amount of the bid. The Commission reserves the right to reject all bids in the event the number of working days bid appears excessive. Until the final award of the contract is made, the right is reserved to reject any and all proposals and to waive technical errors and to advertise for new proposals, or to do the work otherwise when in the opinion of the Engineer the best interest of the State will be promoted thereby.

Award of Contract: The award of the contract, if it be awarded, will be made only upon the recommendation of the Engineer, to the lowest responsible bidder whose proposal shall comply with all the requirements necessary to render it formal. The award, if made, will be within 30 days after the opening of the proposals, but in no case will an award be made until all necessary investigations are made into the responsibility of the bidder to whom it is proposed to award the contract.

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. In the event of the failure of the bidder to whom award is made to enter into contract with the State and to furnish satisfactory sureties therefor, within ten (10) days after notice has been given the bidder by the Commission of the award, the right is reserved by the Commission to award the contract to the next lowest bidder, or advertise for new proposals, or to do the work otherwise when in the opinion of the Engineer the best interest of the State will be promoted thereby.

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 original bond. Bond shall be given on the form provided by the Commission.

Execution of Contract: The contractor whose proposal is accepted will be required to execute the contract and furnish satisfactory bond within ten days of the award. The seal of the Corporation shall be affixed to the contract and attested by the Secretary.

Failure to Execute Contract: In the event of failure or refusal on the part of the successful bidder to comply with any of the requirements of the proposal, specifications and contract, or of failure or refusal to enter into contract and furnish satisfactory bond within the specified time, the amount of the deposit accompanying the proposal shall become the property of the State and shall be paid to the State Treasurer as liquidated damages, in view of the difficulty of determining with exactness the actual amount of damages sustained by the State in such a case.

SECTION 4. SCOPE OF WORK

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 Plans, these Specifications, the Special Provisions, Proposal and Contract. The contractor shall perform all Earth Work, construct all Base Courses and Surface Courses proposed under the contract, build all Structures, Connections with Intersecting Roads and Incidental Construction proposed under the contract, and perform Extra Work, all in accordance with the lines, grades, typical cross-section and dimensions shown on the plans. He shall furnish, unless otherwise provided in the Special Provisions or in the contract, all materials, equipment and labor necessary to the prosecution and completion of the work.

Special Work: Proposed materials, construction or requirements not covered by these specifications will be covered by "Special Provisions" and performed or complied with by the contractor.

Alterations of Plan or of Character of Work: The Engineer may, without notice to the sureties on the Contractor's bond, make alterations: (a) in the design of materials; (b) in the plans or construction; (c) in the quantities or character of the work or materials required; (d) in the cross-sections and dimensions of structures; (e) in shifting of locations to suit conditions disclosed as work progresses, provided such alterations do not change materially the original plans and specifications, and such alterations shall not be a waiver of any condition of the contract nor invalidate any of the provisions thereof. Should such alterations in the plans or character of work result in an increase or decrease in the quantity of the work to be performed the Contractor shall accept payment at the contract unit price for actual work done, in the same manner as if such work had been included in the original estimated quantity. No allowance will be made for anticipated profits.

Additional Work: The Contractor shall perform such work in additional quantities other than those designated in the approximate estimate as may be deemed necessary to complete fully the roadway and structures as planned and contemplated, and shall receive for such additional work payment in full at the unit prices shown in the contract and in the same manner as if such work had been included in the original estimate of quantities.

Extra Work: Unforeseen work made necessary by alteration of plans or of work, or by other reasons, involving increased or decreased unit cost to Contractor, or work necessary to complete the proposed improvement, for which no price is provided in the contract, shall be deemed "Extra Work" and shall be performed by the Contractor in accordance with the specifications and as directed; provided, however, that before any "Extra Work" is started a "Supplemental Agreement" shall be signed by both contracting parties or a written order from the Engineer to do the work on a "Force Account" basis given the Contractor.

Maintenance of Detours: The designation and maintenance of detours and temporary structures necessary for public travel, which are not adjacent or contiguous to the project will be at the charge of the Parish or State unless otherwise provided in the Special Provisions. Other detours and temporary structures will be constructed and maintained by the Contractor and no allowance will be made therefor.

Rights in and Use of Materials Found on the Work: The Contractor, with the approval of the Engineer, may use in the proposed construction suitable stone, gravel or sand found in the "Excavation," 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 location which is not within the excavation, as indicated by the slope and grade lines, without written authorization from the Engineer.

Final Clearing Up: Upon completion of the work and before acceptance and final payment shall be made, the Contractor shall clean and remove from the highway, footways and adjacent property all surplus and discarded materials, weeds, bushes, rubbish and temporary structures, 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. Where work is in the stream, such debris shall generally be removed to the bed of the stream, or as may be specially directed. All materials shall be disposed of as directed by the Engineer and the stream channel, structure and roadway left in a neat and presentable condition. No special payment will be made for this work, its cost being included in the prices paid for the construction work.

Superelevation and Widening: The roadbed and surface course or pavement on all curves on this project shall be superelevated and widened according to the standard plans of the Commission.

SECTION 5: CONTROL OF WORK

Authority and Final Decision 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 may arise as to the quality or acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of the work and shall decide all questions which may arise as to the interpretation of the plans and specifications, and all questions as to the acceptable fulfillment of the contract on the part of the contractor, as to disputes and mutual rights between the contractor and subcontractors under these specifications affecting the integrity of the work, 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.

Plans: Plans will show in detail structures up to and including 20-foot spans, lines, continuous grades, typical cross section of improvement, and general cross sections: plans also will show general features of bridges (over 20-foot span) involved. Such shop details or falsework plans as are necessary shall be furnished by the Contractor, but shall not be used prior to approval. Authorized alterations will be endorsed on approved plans or shown on supplementary sheets.

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 Engineer. 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 by the Engineer of the Contractor's working drawings is general and such approval will not relieve the Contractor from any responsibility whatsoever.

The Contractor shall furnish the Engineer with such blueprint copies of the working drawings as may be required for approval and for construction purposes and upon completion of the work the original tracings, if so required, shall be surrendered to the Engineer. The contract price shall include the cost of furnishing all working drawings and the Contractor will be allowed no extra compensation for such drawings.

Conformity With Plans and Allowable Deviations: Finished surfaces in all cases shall conform with lines, grades, cross sections and dimensions shown on the approved plans. The crown, or rise of the finished surface of the roadway from the curb or side line to the center line, shall be as shown on the typical cross section of the plans, except at intersecting highways or wherever, to insure correct drainage or for other reasons, changes may be directed by the Engineer. Such other deviations from the plans, approved working drawings and specifications as may be required by the exigencies of construction, will in all cases be determined by the Engineer and authorized in writing.

Co-ordination of Plans, Specifications and Special Provisions: These specifications, the accompanying plans, special provisions and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be cooperative, to describe and provide for a complete work. In case of discrepancy, figured dimensions shall govern over scaled dimensions, plans shall govern over specifications, and special provisions shall govern over both specifications and plans.

Cooperation of Contractor: The Contractor will be supplied with two copies of the plans, specifications and special provisions, and he shall have available on the work at all times one copy of each of said plans and specifications and special provisions. He 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 at all times a competent and reliable English-speaking superintendent on the work authorized to receive orders and to act for him. Such superintendent shall be furnished by the Contractor regardless of how much of the work may be sublet. The Contractor must at all times maintain a representative within the bounds of the State and who shall be designated to the Commission to accept service and citation.

Construction Stakes: The Engineer will furnish and set construction stakes establishing lines and continuous profile grade in road work, and center line and benchmark for bridge work, and will furnish the Contractor with all necessary information relating to lines and grades. The Contractor shall furnish, free of charge, all additional stakes, all templates and other 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.

Crown or Cross-Section of Roadway: The typical cross-section shown on the plans shall be implicitly followed as regards the crown or cross-section of the roadway, except where special conditions may, if necessary, make it desirable to change the design, as the Engineer may direct.

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 releasing the Contractor from the fulfillment of the terms of the contract.

Authority and Duties of Inspectors: Inspectors employed by the Louisiana Highway 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 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 specifications and 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 specifications. 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 and decided by the Engineer. The inspector shall not, however, be authorized to revoke, alter, enlarge, relax or release any requirements of these specifications, 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 in any way, or as releasing the Contractor from the fulfillment of the terms of the contract.

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 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 or making good of the parts removed, shall be at the Contractor's expense. No work shall be done nor materials used without suitable supervision or inspection by the Engineer or his representative.

When the United States Government is to pay a portion of the cost of the work covered by this contract, the work shall be subject to the inspection of the representative of the Federal Government. Such inspection shall in no sense make the Federal Government a party to this contract.

Removal of Defective and Unauthorized Work: All work which has been rejected shall be remedied or removed 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 beyond the lines and grades shown on the plans or as given, 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 moneys 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.

Final Inspection: Whenever the work provided and contemplated by the contract shall have been satisfactorily completed and the final cleaning up performed the Engineer shall, unless otherwise provided, make the final inspection.

SECTION 6: CONTROL OF MATERIALS

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.

Samples and Tests: Tests of all materials specified will be made by the Engineer in accordance with the requirements of the United States Department of Agriculture Bulletin No. 1216, Revised, to date, unless otherwise specifically provided. The Contractor shall furnish every facility for the verification of all scales, measures and other devices which he operates. Collecting samples and preparing same for shipment shall be at the expense of the Contractor. The Contractor in all cases shall furnish the required samples without charge.

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.

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 moneys due or to become due the Contractor.

SECTION 7. LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

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 and State laws and local by-laws, ordinances and regulations in any manner affecting the conduct of the work, and 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, by-law, ordinance or regulation, whether by himself or by his employees.

Sanitary Provisions: The Contractor shall observe all rules and regulations of the State Board of Health, or of all local health officials, and must take such precautions as are necessary to avoid unhealthy conditions.

Permits and Licenses: The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

Patent Fees, Royalties and Licenses: 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 claims for infringement by reason of the use of any such patented design, device, material, or process, or any trade mark 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 at any time during the prosecution or after the completion of the work. Specifications for patented pavements may be submitted, but bids on such pavements will not be considered without written permission from the Engineer. Patented pavements must be within the aggregate grading requirements of the specifications.

Public Convenience and Safety: The safety of the general public along or near the road and the convenience of traffic are to be regarded as of prime importance. If the Contractor constructs temporary bridges or provides temporary stream crossings, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings. Materials stored upon the highway shall be placed so as to cause only unavoidable obstruction to the traveling public. No section of road shall be closed to the public except by express permission of the Engineer, which permission may be revocable by the Engineer at any time. When the road under construction is being used by 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 over same in comfort and safety. The Contractor shall, at his own expense, "road machine" the subgrade and all courses adapted to such treatment when and as directed by the Engineer. When so provided on the typical cross-section, and directed by the Engineer, concrete base, concrete pavement, and other suitable pavements shall be constructed one-half at a time, opened and maintained for traffic. The Contractor shall cooperate with the Engineer in the regulation of traffic. Convenient access to all fire hydrants shall be maintained at all times.

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 safety of the public. Highways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. All barricades and obstructions shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise, all of which shall be done in a manner approved by the Engineer. The Contractor will be held responsible for all damage to the project due to failure of the signs and barricades to properly protect the work from traffic, pedestrians, animals, and from all other sources, and whenever evidence of any such traffic is found upon the unaccepted work the Engineer will order that the work, if, in his opinion, it is damaged, be immediately removed and replaced by the Contractor without cost to the Commission.

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. All explosives shall be stored in a secure manner and all such storage places shall be marked clearly, "DANGEROUS—EXPLOSIVES," and shall be in care of competent watchmen at all times.

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 and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed. 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. The Contractor shall move back and rebuild all existing fences within the right-of-way, and shall build all new fences required to protect adjacent property, crops, etc., and will be held responsible for any damage resulting from his failure to do so. 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 (48) 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 moneys 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.

Responsibility for Damage Claims, Etc.: The Contractor shall save harmless the Commission and all of its representatives from all suits, action, 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 unac-

ceptable materials in the construction of the improvement or on account of any act or omission, by the said Contractor, or from any claims or amount arising or recovered under the "Workmen's Compensation Laws," or any other law, by-law, ordinance, order or decree. The Contractor shall carry at his expense, Workmen's Compensation Insurance as, and to the extent, provided by law. He shall not be released from said responsibility until the roadway shall have been completed and 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, but in any case not less than twenty (20) per cent of the contract price, may be held until such aforesaid claims have been settled and suitable evidence to that effect furnished to the Commission.

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 damage 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. In case of suspension of work from any cause whatever the Contractor shall be responsible for all materials, and shall properly store them if necessary; he shall provide suitable drainage of the roadway and erect temporary structures where necessary.

The Contractor will be required to maintain the road in first-class condition until final acceptance. Whenever, in the opinion of the Engineer, any roadway, or portion thereof, is in acceptable condition for travel, it shall be opened to traffic as may be directed and such opening shall not be held to be in any way an acceptance of the roadway or any part of it, or as a waiver of any of the provisions of these specifications and contract. Necessary repairs or renewals made on any section of the roadway, due to its being opened to travel under instructions from the Engineer, to defective materials or work, 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 road, until final acceptance of such section, in a manner approved by the Engineer. Work on this contract will be accepted in sections if so shown on plans, but the retained percentage amount will not be paid on any section until completion and acceptance of the entire project.

Restoration of Surfaces After Openings Have Been Made in the Highway: Any individual or corporation wishing to make an opening in the highway must secure a permit from the Commission and the Contractor shall not allow any person to make an opening unless a duly authorized permit of the Commission is presented. Until the final acceptance of the work, the Contractor shall make any necessary repairs in the roadway when openings have been made by authority of the Commission. Such repair work will be paid for by the Commission as "Extra Work."

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 said 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.

SECTION 8. PROSECUTION AND PROGRESS OF WORK

Subletting or Assigning of Contract: The Contractor shall not let or transfer this contract or any part thereof (except for the delivery of materials) without the consent of the Engineer in writing. Before any work is sublet or assigned by the Contractor, he shall advise the Engineer in writing, giving a description of the work to be sublet, the name of the subcontractor, the terms of the prospective sub-contract, the number of teams and the amount of equipment owned by the subcontractor and the time required for completing the work. He shall also furnish the Engineer a statement from the subcontractor advising that he understands the plans and specifications and is properly qualified to perform such work. No subcontract shall be valid until approved by the Engineer in writing.

Prosecution of Work: The Contractor shall begin the work to be performed under the contract within not more than ten days after the effective date of the contract. The working days shall start ten (10) days after the effective date of the contract. The Contractor shall notify the Engineer at least forty-eight hours before beginning work. He shall start the work at the part of the road designated by the Engineer, shall prosecute the work at as many different points as the Engineer may direct, and shall complete any portion of the work in such order of time as the Engineer may require.

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

Soldiers, Sailors and Marines: In the employment of labor, for the performance of this contract, preference shall be given, other conditions being equal, to honorably discharged soldiers, sailors and marines, but no other discrimination among citizens of the United States shall be made. The Contractor shall also observe all State and Federal laws regulating the employment of laborers and mechanics on all public buildings and public works.

Character of Workmen and Equipment: The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time specified. Failure by the Contractor to provide adequate equipment or labor may result in the annulment of the contract as hereinafter provided. Any foreman or workman employed by the Contractor or by any subcontractor who, in the opinion of the Engineer or his authorized representative, 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 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 the 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.

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 bases, pavements or structures, or in any trade, shall have had sufficient experience in such work to properly and satisfactorily perform it and operate the equipment involved, and shall make due and proper effort to execute the work in the manner prescribed in these specifications. Otherwise the Engineer may take action as above prescribed.

Temporary Suspension of Work: The Engineer may stop by written order any work or any part of the work under this contract, if the methods are such that unsatisfactory work might result. The work shall be resumed when conditions are favorable and methods are corrected, as approved in writing by the Engineer.

Application for extension of time must be approved by the Engineer and shall be accompanied by the formal consent of the sureties on the contract bond, but an extension of time, whether with or without such consent, shall not relieve the sureties from the obligations, which shall remain in full force until the discharge of the contract.

The Engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. Such suspension shall not in any way relieve the Contractor of any responsibility. The Contractor shall not suspend the work without authority.

Method of Computing the Time Allowance for Completing the Work: If the Contractor shall be delayed in the performance of the work from any cause for which the State is responsible or for any cause beyond the control of either parties to this contract, he shall immediately notify the Engineer in writing, fully explaining the cause of said delay and shall be granted such extension of time as the Engineer may deem equitable and just, providing that such extension does not affect the validity of the Contractor's bond. The Contractor shall perform fully, entirely and in acceptable manner the work contracted for within the time stated in the contract. In adjusting the contract time for the completion of the proposed improvement, the length of time expressed in days and parts of days, during which the prosecution of the work has been delayed or suspended in consequence of the unsuitable condition of the weather or other unfavorable conditions, or by any act or omission of the Commission and not by any fault of the Contractor, shall be allowed the Contractor and excluded from the computation in making said adjustment, all of which shall be determined by the Engineer, who shall certify thereto in writing and whose deter-

mination and certification shall be binding and conclusive upon both parties to the contract. Sundays and all legal holidays during which no work has been performed shall be excluded from said computation. Saturday shall also be counted as a full working day. In case the final estimate exceeds the contract estimate, an extension in the working days will be granted the contractor. This extension shall be in direct proportion to the amount of total overrun expressed in dollars, that is the percentage of overrun shall first be computed and the working days shall be increased by the same percentage. Expressed mathematically, the total final working days allowed will equal the final estimate multiplied by the contract working days, divided by the contract estimate. No allowance shall be made for delay or suspension of the prosecution of the work due to fault of the Contractor.

Failure to Complete Work on Time: Should the Contractor fail to complete the work in the time agreed upon 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 expense due to the employment of Engineers, Inspectors, and other employees after the expiration of the number of working 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. The number of working days shown on the estimates shall govern in computing liquidated damages. Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time of completion may have been extended, shall in no way operate as a waiver on the part of the Commission of any of its rights under this contract.

Annulment of Contract: 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 Commission, 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, and shall so certify in writing to the Commission, that the work or any part thereof is unnecessarily or unreasonably delayed or that the Contractor has violated any provision of this contract, the Commission may notify the Contractor to discontinue all work or any part thereof, and thereupon the Contractor shall discontinue such work, or such part thereof as the Commission may designate, and the Commission may thereupon, by a contract, or otherwise as it may determine, complete the work, or such part thereof, and charge the entire expense of so completing the work or part thereof to the Contractor; and for such completion the Commission, for itself or its Contractors, may take possession of or use or cause to be used in the completion of the work or any part thereof, any of such equipment or materials of any description as shall be found upon the line of said work, and thereafter accounting for, or paying, to the Contractor a reasonable compensation for the use of said equipment or materials.

All costs and charges that may be incurred under this article or any damages that should be borne by the Contractor, shall be withheld or deducted from any moneys then due, or to become due the Contractor, under this contract, or any part

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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 shall be entitled to receive the difference and in case such costs and charges shall exceed the said sum, the Contractor shall pay the amount of excess to the Commission for the completion of the work.

SECTION 9: MEASUREMENT AND PAYMENT

Measurement of Quantities: The determination of the quantities of the work performed under this contract will be computed by the Engineer, and based on measurements taken by him or his assistants. United States Standard measures shall, unless otherwise agreed upon in writing, be used. In computing volumes, the method of average end areas will be used for the several classes of excavation and other earthwork quantities, and the prismoidal formula for masonry. All longitudinal measurements for area will be made along the actual surface of the roadway and not horizontally, and no deduction will be made for fixtures in the roadway having an area of 9 square feet or less. For all transverse measurements for area of base courses, surface courses and pavements, the dimension to be used in calculating the pay area shall be the neat dimension shown on plans or ordered in writing by the Engineer.

Scope of Payment: The Contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor and equipment necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements or from any unforeseen difficulties which may be encountered during the prosecution of the work until its final acceptance by the Engineer, and for all risks of every description connected with the prosecution of the work, also for all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified, and for any infringement of patent, trade mark, or copyright; and for completing the work according to the plans and specifications. The payment of any current estimate shall in no way affect the obligation of the Contractor, at his own cost, to repair or renew any defective parts of the construction or to replace any defective materials used in the construction under contract and to be responsible for all damages due to such defects. No moneys 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.

Removal of existing bridges with their approaches will be paid for at the contract "lump sum" price where a bid is requested in the proposal. Otherwise existing bridges with their approaches shall be removed at the expense of the Contractor.

Payment and Compensation for Altered Quantities: When alterations in plans or quantities of work as hereinbefore provided for 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.

Extra and Force Account Work: Extra work ordered and accepted shall be paid for under a "Supplemental Agreement" or as force account, as agreed upon. If the parties at interest are unable to reach an agreement as to the unit prices to be used as the basis of a "Supplement Agreement," the Engineer may order the Contractor to do the work on a force account basis. No extra work not covered by a supplemental agreement or by a written force account order will be paid for.

When alterations in the plans or the work are productive of increased unit cost or decreased unit cost to the Contractor, a fair and equitable sum to be fixed and shown in a "Supplemental Agreement" signed by both contracting parties before such work is started, shall be added or deducted from the contract unit price as the case may be. When the Engineer deems it impracticable to handle any extra work ordered on the unit price basis the supplemental agreement may be made up in any practical form desired, or the work may be ordered done and paid for on a force account basis.

When work 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 extensions, for each laborer, foreman, and team engaged.
- (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.
- (f) When work is complete, the cost of Workmen's Compensation Insurance.

All extra work done by "Force Account" will be paid for as follows: (a) For all labor, teams, and foremen in direct charge of the specific operation, the Contractor shall receive the current local rate of wage, to be agreed upon in writing before starting such work, for each and every hour that said labor, teams, and foreman are actually engaged in such work, to which shall be added an amount equal to ten (10) per cent of the sum thereof, to cover overhead expense, tools and superintendence. In addition to the payments above mentioned, the Contractor shall be reimbursed in the amount of the actual payments made by him for premiums on "Workmen's Compensation Insurance" for laborers and foremen actually engaged on force account work. No charge shall be made by the Contractor for organization, overhead expense, nor shall any charge for superintendence be made except when there shall be necessarily employed on the proposed extra work at any time in one place six laborers or more, in which case a foreman may be employed and his actual expense to the Contractor charged to the extra work for the actual time employed.

(b) For all materials used, the Contractor shall receive the actual cost of such materials including freight charges, as shown by original bills, and certified copies of such bills shall be filed with the Commission.

(c) For any machinery, trucks, power tools or equipment, including 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 each and every hour that said machinery, trucks, power tools or equipment are in use on such work and to which sum no percentage shall be added.

The compensation as herein provided shall be received by the Contractor as payment in full for extra work done on a force account basis, and shall include

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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 (20th) day of the estimate month in which the work was actually performed, and shall include all labor charges, etc., and material charges.

Partial Payments: So long as the work herein contracted for is prosecuted in accordance with the provisions of this 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 80% 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 twenty 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 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 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.

Acceptance and Final Payment: Upon the completion and acceptance of the work the Engineer shall execute a certificate over his signature that the whole work provided for in this agreement has been completed and accepted by him under the terms and conditions thereof, 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 percentage, 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; provided, however, that before the payment of said final estimate shall be made, the Contractor shall submit to the Engineer a certificate, the date of which certificate shall be not prior to the expiration of forty-five (45) days after the certificate of acceptance was recorded, 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 acceptance by the Contractor of the last payment as aforesaid shall operate as and shall be a release to the Commission, the Engineer and other members or

agents thereof from all claims of liability under this contract for anything done or furnished or relating to the work under this contract, or for any act or neglect of said Commission, Engineer, or any of its agents or employees relating to or connected with this contract.

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.

No Waiver of Legal Right: The Commission reserves the right, should conclusive proof of defective work or materials used by or on the part of the Contractor be discovered after the final payment has been made, to claim and recover by process of law such sums as may be sufficient to correct the error or make good the defects in the work and materials.

PAMPHLET "B"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

AUGUST, 1932

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Item 18.	Plank Gate.
Item 19.	Pressure Jetting of Embankment.

ITEM 1. CLEARING

1.01 Description: Clearing shall consist of the cutting, removal, burning and cleaning up of all timber, brush, stumps and lapwood from within the limits of the entire right-of-way; also from such areas as may be required for off-take ditches, channel changes, borrow pits, etc., as directed by the Engineer. No payment will be made under this item for the removal of isolated trees and stumps encountered within the right-of-way, nor for the removal of stumps encountered in the sub-grade. The cost of this work shall be included in the price bid on excavation or borrow or other pay items. Trees and stumps will be considered isolated when they are fifty (50) feet or more apart. The proper removal and disposal of growing crops will be considered as clearing, the acreage to be determined on a percentage basis by the Engineer, consideration being given to the kind and maturity of the crop.

1.02 Construction Methods: Trees, brush, stumps, etc., shall not be thrown on adjacent lands, but shall be disposed of within the limits of the clearing. Trees unavoidably falling outside of the specified limits shall be cut up, removed to within the clearing, and disposed of. Timber of any value which it may be necessary to cut shall be cut in logs of standard lengths and shall be piled neatly along the right of way on the down-stream side, or on abutting property, if directed by the Engineer. Trees that may tend to beautify and will not damage the road shall not be removed without the permission of the Engineer even though they come within the limits described above. 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 (15) feet over the roadway.

Such material as is not removed or stock piled shall be piled in the right of way and burned in such a manner as not to injure any trees or merchantable timber or other property on the right of way or abutting property.

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

All trees, logs, stumps, roots, brush, etc., not disposed of by burning or disposed of as timber of merchantable value, shall be deposited along the right-of-way or on abutting property, with written permission of the property owners, but must be placed on the down-stream side of the center line of the highway, as directed by the Engineer.

1.03 Method of Measurement: Clearing will be measured by the acre and the quantity to be paid for will be determined by measurement of the area actually cleared, as required by the Engineer.

1.04 Basis of Payment: This work shall be paid for at the contract unit price bid for clearing, which price shall include all materials, tools, appliances and machinery, labor and incidentals necessary to satisfactorily do the work. Clearing of off-take ditches, channel-changes, borrow pits, etc., beyond the limits of the right-of-way, shall be paid for at the contract unit price for clearing for the area actually cleared.

ITEM 2. GRUBBING

2.01 Description: Grubbing shall include the excavation and removal of all stumps, roots, submerged logs, corduroy and other perishable and objectionable matter from within the limits of the slopes, also from such areas as may be required for off-take ditches, channel changes, borrow pits, etc., as directed by the Engineer. No payment will be made under this item for the removal of isolated trees and stumps encountered within the right-of-way, nor for the removal of stumps encountered in the subgrade. The cost of this work shall be included in the price bid on excavation or borrow or other pay items.

2.02 Construction Methods: In the operation of grubbing, all stumps, roots, etc., shall be removed to a depth of not less than one (1) foot below the finished surface of section within slopes, ditches, etc., where directed. In roadway, excavation and borrow pits all stumps, roots, etc., shall be grubbed to a depth of not less than one (1) foot below the finished surface. In embankments of two (2) feet or less in height, all stumps, roots, etc., within the limits of the slopes shall be grubbed and removed and bunched or piled along edge of clearing, or otherwise disposed of as directed by the Engineer. Piles of stumps shall not be less than one hundred (100) feet apart. Wherever possible these piles of stumps and roots shall be burned or otherwise disposed of. Where stumps are of such size that they cannot be readily handled, they shall be broken up. In swampy sections or elsewhere, if so directed by the Engineer, grubbing with explosives will not be permitted.

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

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 compactness as the surrounding subgrade.

All grubbing shall be done a satisfactory distance ahead of the grading operations.

2.03 Method of Measurement: Grubbing will be measured by the acre and the quantity to be paid for will be determined by the measurement of the area actually grubbed, as required by the Engineer.

2.04 Basis of Payment: This work shall be paid for at the contract unit price bid for grubbing, which price shall include all material, tools, appliances and machinery, labor and incidentals necessary to satisfactorily do the work.

ITEM 3. DRAINAGE EXCAVATION

3.01 Description: Drainage ditches shall be constructed where shown on the plans or as ordered by the Engineer in writing. Drainage excavations shall be interpreted to mean: inlet and outlet ditches to structures and roadway, changes in channels of streams, berm ditches, ditches parallel to or adjacent to roadway, and hand ditches draining borrow pits, but beyond the limits of the roadway section as constructed, whether the excavation is dry or wet, and providing for the disposition of the material. All other ditches shall be paid for under common excavation. Lines, grades and cross-sections for drainage ditches will be given by the Engineer.

3.02 Construction Methods: The Contractor will be required to excavate the drainage ditches before the pavement is laid and in general at the time the rough grading is done. No deviation from alignment, grade, or section, will be allowed except by written consent of the Engineer. All roots, stumps and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade, and shape of the section shown. The Contractor shall dispose of the excavated material as directed by the Engineer, and he may be directed to place the topsoil on one side of the ditch and the subsoil on the other. The material excavated from all ditches and channel changes shall be placed in the embankments and berms, or used for widening the same, as directed by the Engineer, and it is thoroughly understood that the price bid per cubic yard for drainage ditches and channel changes shall cover all cost of properly placing same in the embankment and berms. No excavation, or spoil, from a ditch shall be deposited or left within three (3) feet of the edge of ditch, unless otherwise shown on the plans or directed by the Engineer in writing. The Contractor shall maintain and keep open and free from earth, sticks, and other debris all ditches dug by him, during the period he is to maintain the road.

3.03 Method of Measurement: Excavation from drainage ditches will be measured in its original position by cross-sectioning and computing by the average end area method, to ascertain the amount of material removed.

3.04 Basis of Payment: This item will be paid for at the contract unit price per cubic yard for "Drainage Excavation," which price shall include all material, tools, appliances and machinery, labor and incidentals necessary to satisfactorily complete the work.

ITEM 4. ROADWAY EXCAVATION

4.01 Description: Roadway excavation shall include all excavation within the limits of the typical cross-section, forming embankments, compacting same, shaping and sloping, the removal and proper disposal of hedgerows, fences, pipes, walls, steps and all existing drainage structures where required by the Engineer, within the limits of the right of way, other than structures shown as a pay item under Items 130 and 135.

All wooden culverts and bridges to side roads or private drives shall be removed where improvements are to be made and shall be immediately replaced after the improvements have been made, as required by the Engineer. The cost of removing and replacing these structures shall be included in the price bid on "excavation" and "borrow".

The Contractor will be required to remove and replace pipe culverts to side roads and private drives, where required by the Engineer. This work shall be paid for as "Roadway Excavation" and the quantity to be paid for will be the volume displaced by the structure plus the material actually removed between vertical planes, one (1) foot outside and parallel to the outside lines of the structure.

4.02 Construction Methods: 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 excavation material shall be wasted without permission 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, which material shall be classified as borrow if beyond the limits of the typical cross-section. 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. Drainage and side ditches shall always be excavated for not less than four thousand (4000) feet ahead of roadway surfacing. Side ditches or gutters emptying from cuts to embankments shall be constructed so as to avoid damage to embankments by erosion. In widened cuts, outside of the slope stakes and within the limits of the right of way, the bottom of the widened cuts shall not be lower than the elevation of the adjacent subgrade unless permitted by the Engineer in writing. Under no conditions will holes be gouged or dug in back slopes or in embankments to obtain material for covering concrete roads, or building shoulders.

In cuts, any material excavated by the Contractor beyond the limits of the typical cross-section of the roadway where no material is needed for borrow, shall be at the Contractor's expense and will not be paid for.

Excavation shall include the removal and satisfactory disposal of all material taken from within the limits of the typical cross-section of the roadway in conformity with the plans and profile, true to the lines and grades given. Also side ditches and off-take ditches except as specified under "Drainage Ditches."

Sod, grass, weeds, and other objectionable matter shall be removed from within the limits of slope stakes on fills of two (2) feet depth and less, but the Contractor shall not receive any compensation for this work, it being understood that his com-

pensation will be covered by the increased amount of material going into the fills, due to the removal of said sod, grass, weeds, or other objectionable matter, which material is fully covered by the unit prices for regular excavation or borrow.

Fences or pipes which are to be re-used shall be removed with care and piled or disposed of in a manner acceptable to the Engineer.

Weep holes not less than three (3) inches in diameter and not more than ten (10) feet apart shall be provided in all abutments, retaining walls and culverts. Their outlet ends shall be placed just above the groundline in front of abutments and retaining walls. In culverts they shall be placed approximately six (6) inches above the flow line. The outside ends of weep holes shall be covered by the Contractor with at least two (2) cubic feet of clean, broken stone or gravel, so placed as to allow free drainage but at the same time prevent the fill from washing out. From approximately six (6) inches below the bottom of the outside ends of the weep holes a column of clean, broken stone or gravel, at least one (1) foot square, shall be carried up, by the Contractor, 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 the Contractor 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.

For foundations through a hard material exposed to erosion, the backfill around piers and in front of abutments and wings may be ordered by the Engineer to be of stone fill or lean concrete, in which case unless otherwise provided this backfill shall be paid for as "Extra Work".

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 twenty-one (21) days.

4.03 Overbreaks and Slides: Overbreaks shall be interpreted to mean the breaking back, or caving in, of any material back of the actual general slope line of the cut, as finally approved by the Engineer. This shall apply to both the top and bottom of the cut. Overbreaks may be due to heavy blasting, or to other causes. Where overbreaks occur, the Contractor shall remove same at his own expense.

Slides shall be interpreted to mean the unavoidable sliding of material along a smooth, well defined seam. They are not likely to occur when the blasting and excavating are carefully performed, but in seamy formations the vibrations due to heavy blasting will greatly augment the possibility of a slide. The Contractor shall, therefore, take every possible precaution when working in such formations to prevent the material from sliding, and he may be required to cut a ditch or trench above the upper slope line so as to drain the surface water away from the seams, which work shall be paid for at the regular unit price for drainage ditch excavation.

In heavy earth or clay cuts which are taken out by a steam shovel, the possibility of slides and overbreaks may be greatly reduced by dressing the slopes to a uniform ratio, as 1 to 1, $\frac{3}{4}$ to 1, or $\frac{1}{2}$ to 1, according to the nature of the material, and in cases which in the opinion of the Engineer are likely to break back or slide, the

Contractor shall dress his work to the required slope. All slides, which in the opinion of the Engineer were unavoidable, and which bear no evidence of heavy blasting shall be classified as "Common Excavation" and paid for accordingly, but the Contractor shall remove at his own expense any slide which bears evidence of careless work or heavy blasting.

The width of the roadbed in cuts is shown by a typical section in the plans. The Contractor will not be paid for excavating cuts of a greater width than that shown by the typical section, unless same be staked off as a borrow pit or as a widened curve.

When the use of a dredge or drag line is permitted or stipulated, and when the Engineer deems it necessary, the Contractor will furnish one (1) or more men to act as spotters on the embankment. These men are to flag the dredge or drag line operator and supervise the placing of material in the embankment.

4.04 Lines and Grades: The Contractor shall follow the marks indicating the lines and grades as set by the Engineer, but if, for any reason, it shall appear to the Contractor that errors have been made in setting such marks, he shall report the same to the Engineer and await his advice before proceeding.

No payment will be made for work which may have been done beyond the lines and directions given by the Engineer, except as stated under "Overbreaks and Slides".

4.05 Embankments: Embankments shall be formed according to the classifications outlined under paragraphs 4.05-A, 4.05-B and 4.05-C below, except in cases where the plans call for Dredged Embankment or Hydraulic Embankment, in which case Item 8, Dredged Embankment, or Item 9, Hydraulic Embankment, as the case may be, will apply.

Where draglines are used as permitted in the paragraphs below, the layers shall be put up for the entire length of fill, except where fills are more than 2,000 feet in length, the layers may be placed in 2,000 foot sections. Each layer shall be leveled off with a tractor and blade, the blade to be not less than eight feet in length.

Stumps, trees, rubbish, sod, or other unsuitable material or substances shall not be placed in the embankment. When embankments are to be made on a hill side, sloping more than thirty (30) degrees from the horizontal, the slope of the original ground on which the embankment is to be placed shall be ploughed deeply or cut into steps before the filling is commenced. 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 negligent work on the part of the Contractor, and not attributable to the unavoidable movement of the natural ground upon which the embankment is made. Embankments over and around pipes, culverts, arches and bridges, shall be of selected materials, placed and thoroughly tamped, puddled and compacted as directed by the Engineer, so as to avoid undue strain to the structure. Stone columns shall be brought up from weep holes as provided for in Bridge Specifications under "Back-filling". All traffic over the work during the construction shall be distributed so as to cover the entire surface of each layer.

No trestles will be allowed in the construction of embankments without written permission from the Engineer. When their use is permitted no portion of the trestle shall come under any part of the proposed location of pavement, including widened curves. Trestles so located may be left in place, provided they are cut two (2) feet below subgrade.

4.05-A Embankments Constructed Preparatory to the Laying of Concrete Pavement:

Embankments constructed under this classification shall be formed of suitable material placed in successive leveled layers of not more than twelve (12) inches in depth for the full width of the cross-section. These twelve (12) inch layers may be placed in two (2) sections provided the next twelve (12) inch section above, breaks joints by not less than four (4) feet. Each layer shall be thoroughly rolled with a ten (10) ton Power driven Roller. Each layer should be thoroughly rolled in a manner satisfactory to the Engineer.

The use of drag lines will not be permitted on the construction of any embankment of three (3) feet in height and under except where embankment consists of widening existing roadbed for the construction of shoulders. In no case will drag lines be permitted to construct any embankment with the machine or any portion of it resting on, or the weight of same being transferred to, the paving slab. 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.

Drag lines will be permitted on the construction of embankment of over three (3) feet in height, the embankment to be placed in twelve (12) inch layers, as specified, and pressure jetted as per Item 19 of these specifications.

4.05-B Embankments Constructed Preparatory to the Laying of Surface Treatment: Embankments constructed under this classification will meet the requirements as specified in Paragraph 4.05-A, except that no pressure jetting will be required, the entire height of fill to be placed in twelve (12) inch layers and each layer rolled.

It is further provided that, due to the character or condition of the soil or method of construction, it may be found impracticable to roll some sections of embankment. Therefore, the rolling of the embankments in twelve (12) inch layers will be bid on as a separate item. Item 4.20 Rolled Embankments, will apply.

4.05-C Embankments Constructed Preparatory to the Laying of Shell, Gravel or Crushed Stone Surfacing: Embankments constructed under this classification will meet the requirements as specified in Paragraph 4.05-A, except that no rolling or pressure jetting will be required.

The requirements of Par. 4.05-C shall also apply to projects let for grading unless otherwise specified in the Special Provisions:

4.06 Disposal of Surplus Material: All surplus excavation and waste material shall be used uniformly to widen embankments or flatten the slopes, or deposited in such other places and for such purposes as the Engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the Engineer.

4.07 Subgrade: The subgrade shall be properly shaped, rolled and uniformly and firmly 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 (4) to ten (10) tons or a power-driven roller weighing not less than one hundred seventy (170) pounds per inch width of tread. Subgrade for macadams shall be rolled with a ten (10) ton three wheel, power-driven roller, wherever possible. Any portion inaccessible to the roller shall be compacted thoroughly with hand tampers weighing not less than fifty (50) pounds, the bearing or tamping face of which shall not exceed one hundred (100) square inches in area. All unsuitable soft and yielding material which will not compact readily shall be removed and back-filled with suitable material and the subgrade shall again be rolled until no depressions develop. Under no conditions will material for back-fill be taken from embankments to a greater depth than sub-grade elevations or from holes dug in the back slopes, this excavating and back-filling to be paid for at the unit price bid per cubic yard for common excavation. Should sufficient time elapse between the rough grading and the laying of pavement to allow the earth to become baked and hardened, whether traffic has been allowed on the subgrade or not, the surface shall be rescarified and rerolled. Frost crystals or mud caused by freezing and thawing shall be removed before placing any roadway material on the subgrade, and shall be replaced with suitable material.

The subgrade must be in a condition so that it will drain readily. In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade, 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.

The subgrade shall be in final condition for receiving roadway materials for a distance of at least five hundred (500) feet in advance of the placing of the roadway materials, forms, etc. No roadway materials, forms, etc., shall be placed until the subgrade has been approved. In the case of concrete pavements and concrete base course pavements, no materials shall be allowed under subgrade.

If the roadway of the present road is of macadam or and conforms approximately to the grade of the proposed roadway, then the macadam road shall be scarified to a depth of six (6) inches or as directed by the Engineer and to the width of the proposed surfacing and shaped to conform to the proposed section uniformly compacted.

If the roadway of the present road is of gravel or follows the traveled way of an old road or a furrowed field, then the surface which is beneath the new surfacing shall be thoroughly ploughed and scarified to a depth of six (6) inches below the original surface or as directed by the Engineer after which it shall be reshaped and rolled as hereinbefore specified. This is to secure a subgrade of uniform rigidity.

The subgrade will be considered as that portion of the highway on which the surfacing rests, except that for brick, concrete, or hard surface roads having a concrete base, the subgrade shall be interpreted to mean the area lying between points one (1) foot outside that portion on which the surfacing rests. No payment for excavation will be allowed for this additional width.

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.

When the road is to be surfaced with gravel, it shall be graded, according to the specifications, true to the line and grade shown on the plans.

The subgrade shall be free from boulders, loose stones, muck, quicksand, and all vegetable matter, or other material that in the opinion of the Engineer would prove detrimental to the road. All large, loose rocks or boulders extending close to the surface of the subgrade shall be broken off twelve (12) inches below the surface of the subgrade and removed.

On all types of construction, the subgrade and the roadway shall be super-elevated and widened on curves as directed by the Engineer in accordance with the standard plans.

4.08 Shoulders: Shoulders of the width and shape shown on the plans shall be constructed of approved material. They shall be carefully machined and dressed after the road has been completed. They shall be brought true to the cross-section of the finished road, and be free from dips, bumps, or irregularities in alignment.

The shoulders shall be graded so that they will drain properly and so that no water will lie along the edge of the completed pavement, surfacing, or in the adjacent ditches. Progress on this shoulder and ditch work shall not be more than four thousand (4000) feet behind the last laid pavement or surfacing, except in the case of concrete pavements where the fourteen (14) curing days have not elapsed or where an industrial system is used. The cost of constructing shoulders is included in the unit price bid for "excavation" or "borrow", as the case may be, and no additional payment will be made for the construction of same.

4.09 Fine Grading: In the event the surfacing is let under a separate contract from the rough grading, the price bid for excavation shall be the full compensation for the preparation and completion of the subgrade, shoulders, and ditches in accordance with the specifications and plans provided.

4.10 Methods of Measurement: All excavation will be measured in its original position by cross-sectioning and computed by the average end area method to ascertain the amount of material removed. Embankment measurement will not be allowed except by written permission of the Engineer.

Measurements of material excavated to place structures will be made by the Engineer, and the quantity of this material placed in the embankment will be considered when computing the quantity of overhaul on excavation and borrow.

No direct payment will be made for excavating and disposing of the materials required to be moved, in order to build the structure, as the cost of this work shall be included in the prices bid for the construction of the structure.

Excavation will be allowed for all existing drainage structures removed and the quantity of excavation to be paid for will be the volume displaced by the structure plus the material actually removed between vertical planes, one (1) foot outside and parallel to the outside lines of the structure.

4.11 Basis of Payment: All excavation will be computed and paid for at the contract unit price per cubic yard for "Roadway Excavation," which price shall include the removal of all obstructions as specified under "Roadway Excavation" within the limits of the right of way, the formation of embankments, refilling around structures, and the disposal of all surface material, preparation of subgrade, shoulders, ditches, and fine grading.

ITEM 4.20. ROLLING EMBANKMENTS

4.21 Description: Rolling embankments shall include the rolling of all embankments as specified under Paragraph 4.05-B of these specifications.

4.22 Equipment: The roller to be used shall be a ten (10) ton Power-driven Roller.

4.23 Method of Measurement: The yardage to be paid for shall be the number of cubic yards accepted rolled embankment measured in place after rolling and placing of embankment have been completed.

4.24 Basis of Payment: This item shall be paid for at the unit price bid per cubic yard for rolling embankments, which price shall be full compensation for furnishing all materials, equipment, tools, labor and all work incidental to compliance with the plans and specifications.

Attention is called to the fact that this pay item for rolling embankments applies only to embankments constructed under paragraph 4.05-B "Embankments Constructed Preparatory to Laying of Surface Treatment". Payment will be made under Item 4.20 Rolling Embankments (per cubic yard).

ITEM 5. BORROW

5.01 Description: When sufficient quantities of suitable materials are not available from the roadway excavation to properly form the embankments, subgrade, and shoulders of the road, such additional material must be obtained from borrow pits furnished by the Highway Commission and located by the Engineer.

5.02 Construction Methods: Preference shall be given the widening of cuts on the inside of curves beyond the limits of the typical cross-section. If the Contractor places more "Borrow" than is required, causing a waste of "Excavation" the amount of such waste shall be deducted from the "Borrow" as measured in the "Borrow Pit". Borrow Pits shall be staked out and cross-sectioned before the Contractor begins work therein. No payment whatever will be allowed the Contractor for any material excavated from Borrow Pits, or elsewhere, prior to the staking out and cross-sectioning of the work by the Engineer. All Borrow Pits shall be so excavated, neatly trimmed, and left in such shape as to admit of accurate measurement after the excavation of the same is completed. Borrow Pits shall also be sufficiently drained so that no water will collect or stand therein.

5.03 Method of Measurement: "Borrow" shall be computed by the method of average end areas from cross-sections obtained before the original ground has been disturbed and immediately after final dressing up of the Borrow Pits. Embankment measurement will not be allowed except by written permission of the Engineer.

5.04 Basis of Payment: All borrow will be paid for at the contract unit price per cubic yard for "Borrow", which shall include the removal and placing of all material in its final position in the highway, and the use of all equipment, tools, labor and work incidental thereto, except that clearing and grubbing of Borrow Pits will be paid for at the contract unit prices per acre for "Clearing" and for "Grubbing".

ITEM 6. OVERHAUL ON EXCAVATION AND BORROW

6.01 Description: Overhaul on Excavation and Borrow shall be considered when it is necessary to haul material a greater distance than the free haul limit of one thousand (1000) feet.

6.02 Method of Measurement: No payment shall be made for hauling material when the length of haul does not exceed the limit of free-haul, which shall be one thousand (1000) feet.

The limits of free haul shall be determined by fixing on the profile two points—one on each side of the neutral grade point, one in the excavation, and the other in embankment—such that the distance between them shall equal the specified free-haul limit and such that the included quantities of excavation and embankment balance. All haul of material beyond the free-haul limit shall be estimated and paid for on the basis of the following method of computation, viz:

All material within this limit of free-haul shall be eliminated from further consideration.

The distance between the center of gravity of the remaining mass of excavation and the center of gravity of the resulting embankment, less the limit of free-haul as above described, shall be the overhaul distance; and the quantity of overhaul shall be computed by the mass-diagram method in units of one (1) cubic yard moved one hundred (100) feet, which units shall be designated as "station-yards".

In case material is obtained from borrow pits along the embankment, and runways constructed, the haul shall be determined by the distance the team, or vehicle, necessarily travels. The overhaul shall be determined by multiplying the number of cubic yards hauled by one-half of the round trip distance made by the team, or vehicle, less the free-haul distance. The runways shall be established by the Engineer.

6.03 Basis of Payment: "Overhaul" shall be paid for at the contract unit price per station-yard, which price shall include all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

ITEM 7. STRIPPING

7.01 Description: This item shall consist of the excavation of the overburden covering the clay or other deposit of which the embankment in swamp or marsh projects is to be constructed. Dry land stripping of gravel or other material pits is not included. This overburden may be composed of stumps, roots, decaying logs, humus, colloidal matter or any material not satisfactory for incorporation in the embankment. The Resident Engineer will decide what material shall be wasted as stripping, and what material is satisfactory for incorporation in the embankment, but a general distinction is that stripping shall be composed of such material from the dredged canal as will decay or otherwise produce unsatisfactory subsidence of the embankment, while the material to be classified as borrow shall be material for which the coefficient of shrinkage has been determined. The stripped material shall be disposed of as indicated on the plans or as directed by the Engineer.

7.02 Method of Measurement: Stripping shall be measured in its original position by the method of average end areas. Original sections will be taken at intervals along the center line not to exceed half stations of fifty (50) feet to determine the quantity of material removed, and shall include such width as is staked out, or as otherwise provided in the "Special Provisions" under the item of stripping.

7.03 Basis of Payment: This item shall be paid for at the contract unit price per cubic yard for "Stripping", which price shall be full compensation for the furnishing of all materials, equipment, tools, labor and incidental work necessary to complete the work in accordance with the plans and specifications.

ITEM 8. DREDGED EMBANKMENT

8.01 Description: This item shall consist of dredging and excavating acceptable material from designated canals and placing the material as ordered in embankments, dressing and completing the embankments in accordance with the specifications and in conformity with the lines, grades and typical cross-section shown on the plans.

8.02 Equipment: The dredge to be used shall meet the approval of the Engineer and 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 unless authorized by the Engineer.

8.03 Material: Material excavated from the canal and to be used in the embankment, must be free from all decayed matter, roots, stumps, logs or other material considered unfit for incorporation in the embankment. Material considered unfit shall be placed on the waste bank side of the canal or the side farthest from the roadway.

8.04 Constructing Embankment: 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 or 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.

When the Engineer deems it necessary, and his request is made in writing, the Contractor shall furnish one (1) or more men to act as spotters on the embankment. These men are to flag the dredge operator and supervise the placing of material in the embankment.

If the difference in elevation of the existing embankment and that of the completed embankment is greater than two and one-half ($2\frac{1}{2}$) feet, the embankment shall be constructed in two (2) or more layers. The quantity of the first layer being determined by the depth of the canal necessary to float the dredge. New material shall be placed in two (2) or more successive operations at least thirty (30) days apart. In the event of severe rainfall or if the material first placed shall not have dried out sufficiently to effect stabilization, the period between operations shall be increased upon orders from the Engineer, but not to exceed sixty (60) days. Material for the second and subsequent layers shall be taken from the bottom of the canal so as to secure as high a proportion of clay or other stable material as possible.

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

8.05 Cross-Section of Canal: The depth of canal on the embankment side shall be only sufficient to float the dredge. This 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.

8.06 Berm: The width of berm shall be standard as shown on the plans.

8.07 Corduroy: Where shown on the plans or directed by the Engineer, the embankment shall be constructed on a corduroy mat. This mat shall be constructed after an approved design and shall consist generally of poles not less than six inches in diameter at the smaller end placed parallel with the roadway on five foot centers. On top of these sleepers will be placed an intermediate layer of poles of not less than two and one-half inches in diameter at the smaller end, and as close together as possible, to form the corduroy. On top of the corduroy and at right angles to it will be placed longitudinal poles parallel with and of the same size as the sleepers. These poles will be called runners and they will be wired through the corduroy to the sleepers by not less than five passes of No. 8 galvanized wire or the equivalent, on five foot centers, or closer if directed by the Engineer. The width of the corduroy shall be equal to or wider than the base of the fill. The basis of payment for corduroy will be covered by special provisions.

8.08 Placing Material on Corduroy: Where corduroy is used the dredged material shall be so placed as not to damage or disarrange the corduroy. Dropping of material on the mat from a greater height than two feet, and unbalanced loading of the mat will not be permitted.

8.09 Dressing Embankment: When the embankment is completed it shall be carefully dressed on top to the satisfaction of the Engineer before any surfacing is placed, and an excessive amount of surfacing required by inequalities of the subgrade will not be allowed on the final estimate.

8.10 Sodding: The shoulders and slopes of the embankment, in all cases where the embankment is over two feet high on the slope, shall be sodded with bermuda or other suitable growth, by setting live roots on twelve inch centers each way, and at least 75% of any given area must be alive and growing before the work will be considered acceptable. The cost of sodding shall be included in the contract price for other items, and will not be considered a separate pay item, unless otherwise specified.

8.11 Method of Measurement: Canal measurement of the original space occupied by the material, computed by the method of average end areas, shall determine the amount of the cubic yards removed. Sections will be taken at intervals along the center line, not to exceed half stations of fifty (50) feet. This measurement to be made not more than forty-eight (48) hours after excavation and on progress estimates, the payment will not cover yardage closer than two hundred (200) feet in the rear of the dredge.

8.12 Basis of Payment: This work, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Dredged Embankment", which price shall be full compensation for all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

ITEM 9. HYDRAULIC EMBANKMENT

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

9.02 Permits: The Contractor must provide himself with the necessary permits from the Federal authorities to operate dredges and other floating equipment in open or other waters under their control, unless otherwise authorized by the Engineer, or specifically shown on plans. Failure to secure such permits will not operate to release the Contractor or his bonding company from responsibility for completion of the work within the time limit.

9.03 Material: Material pumped into the embankment must be free from all humus, colloidal matter, or any material not satisfactory for incorporation in the embankment. The Engineer shall decide what materials may be used for construction purposes.

9.04 Construction Methods: Hydraulic dredge or dredges stationed at points by the Contractor unless otherwise specified, will pump materials found in the lakes, rivers or other waters, consisting of sand, clay or shells through a pipe line not less than fifteen (15) inches in diameter into the embankment. No material for the hydraulic embankment shall be obtained from sources closer than seven hundred fifty (750) feet from the location of the proposed roadway. The Engineer shall have authority to reject materials encountered at the location or successive locations of the hydraulic dredge and considered by him to be unsatisfactory for use in the embankment. Such materials shall be stripped at the Contractor's expense and no payment therefor will be made. The embankment shall be composed entirely of pumped in materials and any muck brought to the top of the embankment shall be removed by the Contractor at his own expense and satisfactory material substituted therefor. The discharge of pumped materials shall not be effected at right-angles to the center-line of the roadway or any existing levees. The discharge pipe, for at least fifty (50) feet must be laid parallel to the center-line of the highway. 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.

9.05 Method of Measurement: The material used in the construction of the embankment shall be measured complete in place as shown by the typical cross-section sheet of the plans. No material placed outside of the typical cross-section shall be paid for unless otherwise specified.

9.06 Basis of Payment: The contract price per cubic yard for Hydraulic Embankment shall be payment in full for the placing of the material within the pay

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sections as shown by typical cross-section on the plans and for dressing the side slopes of the embankment, either to the slope shown or to a flatter slope, if allowed by the Engineer, together with the furnishing of all material, equipment, tools, labor and work incidental to compliance with the plans and specifications.

ITEM 10. REBUILT FENCE

10.01 Description: This item shall consist of taking down, moving back and rebuilding existing fence as indicated on the plans and as directed by the Engineer.

10.02 Methods of Construction: 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 by allowing cattle, horses, mules and other animals to roam through gaps left by his workmen.

10.03 Method of Measurement: This item shall be measured by the station (100 linear feet) of "Rebuilt Fence" complete in place.

10.04 Basis of Payment: "Rebuilt Fence" shall be paid for at the contract unit price per station (100 linear feet), which price shall be full compensation for all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

ITEM 11. NEW BARBED WIRE FENCE

11.01 Description: This item shall consist of the furnishing and construction of a fence consisting of four (4) strands of new barbed wire supported by wooden posts and securely nailed to the posts with wire staples. The posts shall be spaced ten (10) feet center to center. The barbed wire fence shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

11.02 Barbed Wire and Staples: The barbed wire shall be four (4) point hog wire and shall consist of strands of tough annealed 12½ U. S. Standard gauge heavily galvanized.

Staples shall be made of galvanized steel wire and shall be not less than 1¼ inches long.

11.03 Wooden Posts and Braces: Creosoted posts shall be air-seasoned yellow pine impregnated by an empty cell process so as to retain at least five (5) pounds of preservative, Grade 1 Creosote Oil per cubic foot of material and shall be sawn halves from round posts which shall be not less than four and one-half (4½) inches diameter in any place. Cypress, catalpa or white oak posts shall be of sound timber 4"x6", or round posts of not less than four (4) inches in diameter, the bottom two and one-half (2½) feet to be dipped in hot tar pitch. All posts, except gate posts, shall be sawed off square at both ends and shall be six and one-half (6½) feet in length and set in the ground two (2) feet. If round posts are used, they shall be peeled and trimmed of all knots and knobs and shall be straight and smooth.

The braces shall be of sound timber 4" x 4" and shall be placed at angles, corners, gates, at the beginning and end of fence and on straight sections and shall not be more than one thousand (1,000) feet apart.

Construction Methods

11.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The barbed wire shall be nailed to the posts with at least one 1¼ inch staple for each strand and as many additional staples as required to make a secure and workmanlike fence.

11.05 Method of Measurement: This item shall be measured by the station (100 linear feet) of "New Barbed Wire Fence."

11.06 Basis of Payment: This item shall be paid for at the contract unit price per station (100 linear feet) which price shall include all materials, equipment, tools, labor and incidentals necessary to complete the fence according to the plans and specifications.

ITEM 11-B. NEW FENCE POSTS

11.01-B Description: This item consists of the furnishing and installing of new fence posts where required in the reconstruction of old fence. The posts shall meet the requirements of posts for "New Barbed Wire Fence" under paragraph 11.03.

11.02-B Basis of Payment: This item shall be paid for at the contract unit price bid under Item 11-B, which price shall include the furnishing and installing of the post, complete in place, in the fence.

ITEM 12. COMBINATION MESH AND BARBED WIRE FENCE

12.01 Description: This item shall consist of the furnishing and construction of a fence consisting of three (3) strands of new barbed wire and one (1) section of new mesh galvanized wire, supported by wooden posts and securely nailed to the posts with wire staples. The posts shall be spaced ten (10) feet center to center. The combination mesh and barbed wire fence shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

12.02 Barbed Wire, Mesh Wire and Staples: The barbed wire shall be four (4) point hog wire and shall consist of strands of tough annealed 12½ U. S. Standard gauge heavily galvanized.

The mesh wire shall be constructed on the hinged joint principle. The stays or uprights are separate pieces of wire which connect with the horizontal or strand bars and are wrapped securely around the strand, forming a complete joint or lock. Mesh wire to be twenty-six (26) inches high, galvanized and shall not weigh less than six (6) pounds per linear rod. All wire to be basic open hearth steel.

Staples shall be made of galvanized steel wire and shall not be less than 1¼ inches long.

12.03 Wooden Posts and Braces: Creosoted posts shall be air-seasoned yellow pine impregnated by an empty cell process so as to retain at least five (5) pounds of preservative, Grade 1 Creosote Oil per cubic foot of material and shall be sawn halves from round posts which shall be not less than four and one-half (4½) inches diameter in any place. Cypress, catalpa or white oak posts shall be of sound timber 4"x6", or round posts of not less than four (4) inches in diameter, the bottom two and one-half (2½) feet to be dipped in hot tar pitch. All posts, except gate posts, shall be sawed off square at both ends and shall be six and one-half (6½) feet in length and set in the ground two (2) feet. If round posts are used, they shall be peeled and trimmed of all knots and knobs and shall be straight and smooth.

The braces shall be sound timber 4" x 4" and shall be placed at angles, corners, gates, at the beginning and end of fence and on straight sections and shall not be more than one thousand (1,000) feet apart.

Construction Methods

12.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The barbed wire and mesh wire shall be nailed to the posts with one staple for each horizontal strand and as many additional staples as required to make a secure and workmanlike fence.

12.05 Method of Measurement: This item shall be measured by the station (100 linear feet) of "Combination Mesh and Barbed Wire Fence."

12.06 Basis of Payment: This item will be paid for at the contract unit price per station (100 linear feet) which price shall include all materials, equipment, tools, labor and incidentals necessary to complete the fence according to the plans and specifications.

ITEM 13. SODDING

13.01 Description: This item shall consist of providing and planting approved live sod on all fills for protection against erosion, as directed by the Engineer when bids are requested. The sods shall be of suitable size, variety and character for the purpose selected and for the soil upon which it is to be planted, for vigorous and hardy growth, and approved by the Engineer.

13.02 Materials: The sods or tufts shall be of Bermuda grass or some other grass approved by the Engineer and native to the locality of the work, and shall be provided by the contractor and placed as directed.

13.03 Method of Construction: After the embankment has been completed in accordance with the plans and specifications, all fills of two (2) feet or over shall be sodded with turfs of suitable grass. A strip of sod shall be placed on the slope just underneath the shoulder line so as to form one continuous strip of turf about three (3) inches wide and, on the remainder of the slope and upon shoulders similar strips of sod three (3) inches wide shall be planted in continuous rows of twelve (12) inches, center to center. The area of shoulders and slopes to be sodded shall begin at the edge of the surface course and extend to the toe of the slope on each side of the embankment. Sodding shall be done at such times as the Engineer may direct and in such manner that the grass will at once take root.

13.04 Basis of Payment: Sod planted and accepted by the Engineer will be paid for at the contract unit price bid per station (one hundred (100) linear feet), of roadway sodded on both sides to the width required by the Engineer, which price shall be full compensation for furnishing and planting the sod, all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 14. PROJECT MARKERS

14.01 Description: This item shall consist of furnishing and erecting "Project Markers" on concrete posts at the points indicated on the plans, or as directed by the Engineer, and in accordance with the plans and specifications.

14.02 Materials: The posts shall be made out of class "AA" concrete as defined in Item No. 60 of Pamphlet "L" and reinforced as shown on plans. The markers are to be of material as indicated on the plans.

14.03 Construction: The posts shall be set at the points indicated and in the manner specified on the plans, or as directed by the Engineer. The tamping of the earth, in backfilling around the post, shall be done in layers, in order to secure the greatest degree of compaction possible.

14.04 Basis of Payment: This item will be paid for at the contract unit price each for "Project Markers" which price shall be full compensation for all material, equipment, tools, labor and incidentals necessary to complete the work.

ITEM 14.10. RIGHT-OF-WAY MARKERS

14.11 Description: This item shall consist of furnishing and erecting "Right-of-Way Markers" consisting of concrete posts, at the points indicated on the plans, or as directed by the Engineer, and in accordance with the plans and specifications.

14.12 Materials: The markers shall be made out of class "AA" Concrete as defined in Item No. 60 of Pamphlet "L" and reinforced as shown on plans.

14.13 Construction: The posts shall be set at the points indicated and in the manner specified on the plans, or as directed by the Engineer. The tamping of the earth, in backfilling around the posts, shall be done in layers in order to secure the greatest degree of compaction possible.

14.14 Basis of Payment: This item will be paid for at the contract unit price each for "Right-of-Way Markers" which price shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

ITEM 15. SUB-BASE

15.01 Description: This item shall consist of special approved material, hauled, placed, and compacted, as more specifically provided for in the special provisions for the particular project.

15.02 Construction Methods: As provided for in the "Special Provisions."

15.03 Method of Measurement: As provided for in the "Special Provisions."

15.04 Basis of Payment: As provided for in the "Special Provisions."

15.10 Overhaul on Sub-Base: As provided for in the "Special Provisions."

15.11 Method of Measurement: As provided for in the "Special Provisions."

15.12 Basis of Payment: As provided for in the "Special Provisions."

ITEM 16. WIRE FABRIC GUARD RAIL

16.01 Description: This item shall consist of the furnishing and construction of a guard rail consisting of a woven steel wire fabric road guard supported by wooden posts and securely nailed to the posts with 2" wire staples. The posts shall be spaced eight (8) feet center to center. The guard rail shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these Specifications.

Materials

16.02 Wire Fabric: The wire fabric shall be made of No. 6 W. & M. gauge wire (.192 inch diameter). In no case shall the diameter of the wire vary more than 0.003 inches from the size specified. The wire shall be made of basic open hearth metal which before galvanizing shall conform to the Tentative Specification A82-21T of A. S. T. M. with subsequent revisions, and shall have a minimum tensile strength of 60,000 pounds per square inch of cross-sectional area of the galvanized wire. Tensile tests shall be made by taking a picket from roll of fabric, cutting to one foot length, and without previously straightening it, testing in a standard testing machine until the wire breaks. The pickets shall be interwoven to form a continuous fabric without knots or ties. The top and bottom ends of each pair of pickets shall be turned back over each other to form a knuckle. The wire shall be woven in the form of a uniform square mesh having parallel sides approximately two (2) inches apart. The standard width of fabric shall be twenty-four (24) inches. The fabric guard shall be galvanized after weaving and the weight of zinc coating per square foot of wire surface shall be not less than eight-tenths (0.8) oz. and shall withstand a minimum of four (4) one minute dips by the Preece Test. The zinc coating shall not crack, peel or flake during ordinary handling in shipment or erection of the guard.

The zinc used for coating shall be pure Virgin spelter conforming to A. S. T. M. Standard Specifications B-6.

Staples shall be made of No. 6, gauge galvanized wire and shall be not less than two (2) inches long.

16.03 Wooden Posts and Braces: The wooden posts and braces shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least five (5) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. Intermediate posts shall be six inches by six inches by seven feet and set in the ground three feet six inches. The end posts shall be six inches by six inches by eight feet, set in the ground four feet six inches. The braces shall be of four inch by four inch sound timber placed at all end posts and at intervals of not more than two hundred (200) feet

apart. The posts and braces shall be painted with two coats of special aluminum paint after the structure has been erected and has dried from two to four weeks. The first coat must be allowed to dry before applying the second.

16.04 Paint: The paint for painting the posts and braces after erection shall conform to the following requirements:

Pigment—2¼ lbs. Aluminum Powder.

Vehicle—1 Gallon Long Oil Spar Varnish.

Quality of Pigment: The pigment shall consist of Standard varnish (Albron) aluminum powder as manufactured by the Aluminum Company of America or of equal quality. It shall be flake like in structure and absolutely free from filler or adulterants such as mica, magnesium silicate, etc. A sample of the powder, when tested on standard mesh screens, shall show 100% passing through the 100-mesh screen. When suspended in the vehicle, the powder shall form a brilliant, apparently continuous metallic layer on the surface of the liquid promptly after stirring is discontinued.

Quality of Vehicle: The vehicle shall be a hard, dry, long oil, varnish type, containing 50% by weight of non-volatile oils and gum. The consistency will correspond to tubes A to D of the Gardner Holdt Air Bubble Viscosimeter. The ratio of oil to gum shall be approximately three to one. The major portion of the vehicle shall consist of heat treated China wood oil, and the remainder heat treated linseed oil. It shall set to touch in about two hours and dry hard in twelve hours. It shall have highly efficient "leafing" qualities when mixed with 2¼ pounds of Standard Varnish Albron per gallon. The paint shall be mixed on the job and used immediately.

Construction Methods

16.05 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The fabric shall be secured at intermediate posts on side of posts facing the road with five (5) two (2) inch No. 6 staples in each post, one (1) staple at top of fabric, one (1) at bottom and three evenly spaced between top and bottom staples. At each end post, fabric to be carried around three faces of the post and secured with five (5) staples in each face. The bottom edge of fabric shall be elevated above ground line as shown on the plans.

16.06 Method of Measurement: This item shall be measured by the linear foot of "Wire Fabric Guard-Rail," complete in place.

16.07 Basis of Payment: This item will be paid for at the contract unit price per linear foot for "Wire Fabric Guard-Rail" complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard-rail according to the plans and specifications.

ITEM 17. EXPANDED METAL GUARD RAIL

17.01 Description. This item shall consist of the furnishing and construction of a guard rail consisting of expanded metal supported by wooden posts and securely bolted to the posts by means of steel plates. The posts shall be spaced eight (8) feet center to center. The guard rail shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials.

17.02 Expanded Metal. The expanded metal guard rail shall be manufactured of ten gauge open hearth annealed sheets. The total area of steel in cross section of expanded guard rail shall not be less than 0.375 square inches per foot width. The minimum length of sheets (after expansion) shall not be less than 8' 4", and the minimum width of sheets (after expansion) shall not be less than twenty-four (24) inches. All sheets shall be galvanized (hot dipped) after expansion. Unless otherwise specified the size of mesh shall be 5½" x 2¼". The sheets from which the guard rail is expanded shall have the following physical properties: Minimum Requirements: Elastic limit 25,000 lbs. per square inch; elongation 8"-18%; tensile strength 40,000 lbs. per square inch; stand being bent cold through 180 degrees flat on itself, without cracking on the outside of the bent portion.

17.03 Steel Plates and Bolts. Plates for securing guard rail to posts shall be at least four (4) inches wide, one-quarter (¼) inch thick and two (2) inches longer than the width of guard rail, slightly curved and galvanized. Bolts used with plates for securing guard rail to posts, shall be at least one-half (½) inch in diameter and of necessary length. All bolts, washers and nuts shall be galvanized.

17.04 Wooden Posts and Braces: The wooden posts and braces shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least five (5) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. Intermediate posts shall be six inches by six inches by seven feet and set in the ground three feet six inches. The end posts shall be six inches by six inches by eight feet, set in the ground four feet six inches. The braces shall be of four inch by four inch sound timber placed at all end posts and at intervals of not more than two hundred (200) feet apart. The posts and braces shall be painted with two coats of special aluminum paint after the structure has been erected and has dried from two to four weeks. The first coat must be allowed to dry before applying the second.

17.05 Paint: The paint for painting the posts and braces after erection shall conform to the following requirements:

Pigment—2¼ lbs. Aluminum Powder.
Vehicle—1 Gallon Long Oil Spar Varnish.

Quality of Pigment: The pigment shall consist of Standard varnish (Albron) aluminum powder as manufactured by the Aluminum Company of America or of equal quality. It shall be flake like in structure and absolutely free from filler or adulterants such as mica, magnesium silicate, etc. A sample of the powder, when tested on standard mesh screens, shall show 100% passing through the 100-mesh screen. When suspended in the vehicle, the powder shall form a brilliant, apparently continuous metallic layer on the surface of the liquid promptly after stirring is discontinued.

Quality of Vehicle: The vehicle shall be a hard, dry, long oil, varnish type containing 50% by weight of non-volatile oils and gum. The consistency will correspond to tubes A to D of the Gardner Holt Air Bubble Viscosimeter. The ratio of oil to gum shall be approximately three to one. The major portion of the vehicle shall consist of heat treated China wood oil, and the remainder heat treated linseed oil. It shall set to touch in about two hours and dry hard in twelve hours. It shall have highly efficient "leafing" qualities when mixed with $2\frac{1}{4}$ pounds of Standard Varnish Albron per gallon. The paint shall be mixed on the job and used immediately.

Construction Methods

17.06 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The expanded metal shall be secured to the intermediate and end posts on side of posts facing the road with a steel plate bolted to each post with four (4) one-half ($\frac{1}{2}$) inch bolts. The bottom edge of the expanded metal shall be elevated above ground line as shown on the plans.

17.07 Method of Measurement: This item shall be measured by the linear foot of "Expanded Metal Guard Rail", complete in place.

17.08 Basis of Payment: This item will be paid for at the contract unit price per linear foot for "Expanded Metal Guard Rail", complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard-rail according to the plans and specifications.

ITEM 17-A. RESILIFLEX GUARD RAIL

17.01-A Description: This item shall consist of furnishing and delivering the necessary posts, spring supports, rail plates and fastenings, and preparing, assembling, and setting the same, the painting of all wooden and metal portions and the necessary excavating and backfilling of the dimensions, in the manner, at the location, and to the lines, and grades shown on the plans, in these specifications or in the special provisions and proposal.

Materials

17.02-A Rail Plates: Rail Plates shall be made of Open Hearth semi-spring steel, properly tempered for toughness and high 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 each plate from which the rail plates and spring supports are produced shall not be less than 40,000 pounds; the dimensions of the plate being not less than sixteen gauge by twelve inches.

17.03-A Spring Supports: Spring supports shall be constructed with three leaves, the outer leaf having hinged ends for connection with rail plates. Each leaf shall be made of Open Hearth Spring Steel, properly tempered after forming.

17.04-A Fastenings: $\frac{5}{8}$ " x 12" hinge pins shall be furnished for connecting rail members to spring supports, and $\frac{5}{8}$ " x 12" bolts with square washers shall be furnished for fastening spring supports to posts. For anchoring each end section of road guard to end post, three $\frac{3}{4}$ " x 18" bolts with nuts and washers shall be furnished.

17.05-A Galvanizing: Each metal part of the guard rail, including fastenings, shall be galvanized by the hot dip method, and 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-tenths (1.4) 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.

17.06-A All metal parts of the guard rail, after erection, shall be painted with two coats of white lead and oil. Before applying the paint the metal surface shall be slightly etched with a diluted solution of vinegar, composed of one quart vinegar and two gallons of water.

17.07-A Wooden Posts, Braces, and Anchors: The wooden posts, braces and anchors, shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least five (5) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. All posts shall be six inches by eight inches by six feet, set in the ground three feet five inches. The braces shall be of six inch by six inch sound timber placed at all end posts and at intermediate posts as shown on the plans. The posts and braces shall be painted with two coats of special aluminum paint after the structure has been erected and has dried from two to four weeks. The first coat must be allowed to dry before applying the second.

17.08-A Paint: The paint for painting the metal parts after erection shall conform to the following requirements:

Pigment—9 pounds of Sublimed White Lead, 3 pounds of Zinc Oxide.

Vehicle— $\frac{3}{4}$ gallon boiled Linseed Oil, $\frac{1}{4}$ gallon Raw Linseed Oil.

A variation of 5% either way from the quantities of pigment shown by the foregoing formulas will be allowed.

17.09-A Paint: The paint for painting the posts and braces after erection shall conform to the following requirements:

Pigment— $2\frac{1}{4}$ lbs. Aluminum Powder.

Vehicle—1 gallon Long Oil Spar Varnish.

Quality of Pigment: The pigment shall consist of Standard varnish (Albron) aluminum powder as manufactured by the Aluminum Company of America or of equal quality. It shall be flake like in structure and absolutely free from filler or adulterants such as mica, magnesium silicate, etc. A sample of the powder, when tested on standard mesh screens, shall show 100% passing through the 100-mesh screen. When suspended in the vehicle, the powder shall form a brilliant, apparently continuous metallic layer on the surface of the liquid promptly after stirring is discontinued.

Quality of Vehicle: The vehicle shall be a hard, dry, long oil, varnish type, containing 50% by weight of non-volatile oils and gum. The consistency will correspond to tubes A to D of the Gardner Holdt Air Bubble Viscosimeter. The ratio of oil to gum shall be approximately three to one. The major portion of the vehicle shall consist of heat treated China wood oil, and the remainder heat treated linseed oil. It shall set to touch in about two hours and dry hard in twelve hours. It shall have highly efficient "leafing" qualities when mixed with $2\frac{1}{4}$ pounds of Standard Varnish Albron per gallon. The paint shall be mixed on the job and used immediately.

Construction Method

17.10-A Erection: The posts shall be set plumb and firm, spaced and set in the ground as shown on the plans and to 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 back fill and same shall be thoroughly compacted by constant heavy tamping during backfilling operations.

A spring support shall be provided at each post. The rail plates through the spring support shall be securely attached to the posts. The bottom edge of the rail shall be elevated above the ground line as shown on the plans. Before final completion, the posts shall be accurately aligned and re-aligned as may be required before final acceptance.

17.11-A Method of Measurement: The amount of resiliflex guard rail to be paid for will be the actual number of lineal feet (measured from out to out of the end posts) as hereinbefore described, in place, completed and accepted.

17.12-A Basis of Payment: This item will be paid for at the contract unit price as per linear foot for "Resiliflex Guard Rail" complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard rail according to the plans and specifications.

ITEM 18. PLANK GATE

18.01 Description: This item shall consist of the furnishing and construction of a plank gate supported by wooden posts and consisting of six horizontal planks together with all vertical and diagonal pieces and braces, etc., necessary to comply with the detail plan for a Standard Plank Gate. All planks to be securely nailed together with 8-d wire nails. The plank gates shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these Specifications.

Materials

18.02 Lumber and Posts: All lumber and posts shall be No. 1 common cypress s-4-s. The post shall be 6" x 8" x 8', the bottom three (3) feet of posts to be dipped in hot tar pitch. The top corners of posts and uprights on gate to be chamfered 2".

18.03 Hardware: The hinges shall be twelve (12) inch strap hinges and shall be fastened to the gate with 5/16" machine bolts with washers, and shall be nailed to the post with 20-d 1/4" x 4", chisel point, countersunk heads, light Hinge Nails. The chain for fastening the gate shall be galvanized iron "Well Chain" 48" long and secured to the post with three 2 1/2" staples.

Construction Methods

18.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping. The bottom edge of the gate shall be elevated above ground line as shown on the plans.

18.05 Basis of Payment: This item will be paid for at the contract price per gate, complete in place, which price shall be full compensation for furnishing all materials (including posts) equipment, tools, labor and incidentals necessary for the complete construction and erection of the gate and posts according to the plans and specifications.

ITEM 19. PRESSURE JETTING OF EMBANKMENT

19.01 Description: Pressure jetting of embankments shall be performed as directed by the Engineer, not less than thirty (30) days in advance of the laying of the pavement, or at such longer duration of time prior thereto as practical in accordance with following specifications covering same—

In general, all embankments over three (3) feet in height and fills, adjacent culverts and bridges will be pressure jetted.

19.02 Construction Methods: Compacting embankment materials by pressure jetting shall be performed where indicated on the plans or ordered by the Engineer. After the embankment has been brought up to the required height as described in Item 4.05, Pamphlet B, Standard Specifications 1930, except that no rolling will be required. The surface shall be broken up by plowing to a sufficient depth to eliminate any crust which has formed. Pressure jetting of the embankment shall then be done by using a pipe line of not less than one and one-half inches ($1\frac{1}{2}$ ") in diameter, with the nozzle end terminating in a not less than three-quarter inch ($\frac{3}{4}$ ") diameter nozzle. The pressure of the water at the nozzle when delivered shall not be less than seventy-five pounds (75 lb) per square inch. If necessary, the jet holes shall first be opened by spudding with a heavy iron bar, the holes to be placed as directed by the Engineer, and to be not farther than five feet apart on centers. Into these holes, the jet nozzle under full pressure, shall be inserted. As long as the fill will take water the jet shall remain in each hole. When the water begins to overflow from the top of the hole, or adjacent holes, the jet shall be forced down into the fill until it reaches a point within six inches of the bottom of the fill, where it shall remain as long as the embankment absorbs the water or until water oozes out of the sides of the fill. If a hole has to be abandoned temporarily, because of leakage of water from the fill, the jet shall again be applied to it after the adjacent holes have been jetted. The jetting shall begin at the deepest and proceed towards the shallowest part of the embankment. Arching of the surface of the embankment shall be watched for continually and whenever found, the crust shall be broken. Jetting shall be continued until, in the opinion of the Engineer, the embankment is thoroughly settled and compacted. Not less than two weeks in advance of the paving, the Contractor shall backfill all holes with suitable material thoroughly saturated during the backfilling.

The unit price bid for jetting, under this specification, shall include any delay in the Contractor's operations caused by the performance of this work.

19.03 Method of Measurement: The yardage to be paid for shall be the number of cubic yards of accepted jetted embankment measured in place two weeks after the jetting has been completed. The length of fill paid for shall include the distance between end cross-sections holed and jetted, plus ten (10) feet.

19.04 Basis of Payment: This item shall be paid for at the unit price bid per cubic yard for pressure jetting of embankments, which price shall be full compensation for the furnishing of water, pumps, pipe lines and appurtenances, labor, equipment, tools, and all other incidentals necessary to complete the item.

Payment will be made under Item 19, Pressure Jetting of Embankments (per cubic yard).

PAMPHLET "B"

LOUISIANA HIGHWAY COMMISSION

Standard Specifications

February, 1935

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ITEM 1. CLEARING

1.01 Description: Clearing shall consist of the cutting, removal, burning and cleaning up of all timber, brush, stumps and lapwood from within the limits of the entire right-of-way; also from such areas as may be required for off-take ditches, channel changes, borrow pits, etc., as directed by the Engineer. No payment will be made under this item for the removal of isolated trees and stumps encountered within the right-of-way, nor for the removal of stumps encountered in the sub-grade. The cost of this work shall be included in the price bid on excavation or borrow or other pay items. Trees and stumps will be considered isolated when they are fifty (50) feet or more apart. The proper removal and disposal of growing crops will be considered as clearing, the acreage to be determined on a percentage basis by the Engineer, consideration being given to the kind and maturity of the crop.

1.02 Construction Methods: Trees, brush, stumps, etc., shall not be thrown on adjacent lands, but shall be disposed of within the limits of the clearing. Trees unavoidably falling outside of the specified limits shall be cut up, removed to within the clearing, and disposed of. Timber of any value which it may be necessary to cut shall be cut in logs of standard lengths and shall be piled neatly along the right-of-way on the downstream side, or on abutting property, if directed by the Engineer. Trees that may tend to beautify and will not damage the road shall not be removed without the permission of the Engineer even though they come within the limits described above. 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 (15) feet over the roadway.

Such material as is not removed or stock piled, shall be piled in the right-of-way and burned in such a manner as not to injure any trees or merchantable timber or other property on the right-of-way or abutting property.

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

All trees, logs, stumps, roots, brush, etc., not disposed of by burning or disposed of as timber of merchantable value, shall be deposited along the right-of-way or on abutting property, with written permission of the property owners, but must be placed on the downstream side of the center line of the highway, as directed by the Engineer.

1.03 Method of Measurement: Clearing will be measured by the acre and the quantity to be paid for will be determined by measurement of the area actually cleared, as required by the Engineer.

1.04 Basis of Payment: This work shall be paid for at the contract unit price bid for clearing, which price shall include all materials, tools, appliances and machinery, labor and incidentals necessary to satisfactorily do the work. Clearing of off-take ditches, channel-changes, borrow pits, etc., beyond the limits of the right-of-way, shall be paid for at the contract unit price for clearing for the area actually cleared.

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ITEM 2. GRUBBING

2.01 Description: Grubbing shall include the excavation and removal of all stumps, roots, submerged logs, corduroy and other perishable and objectionable matter from within the limits of the slopes, also from such areas as may be required for off-take ditches, channel changes, borrow pits, etc., as directed by the Engineer. No payment will be made under this item for the removal of isolated trees and stumps encountered within the right-of-way, nor for the removal of stumps encountered in the subgrade. The cost of this work shall be included in the price bid on excavation or borrow or other pay items.

2.02 Construction Methods: In the operation of grubbing, all stumps, roots, etc., shall be removed to a depth of not less than one (1) foot below the finished surface of section within slopes, ditches, etc., where directed. In roadway excavation and borrow pits, all stumps, roots, etc., shall be grubbed to a depth of not less than one (1) foot below the finished surface. In embankments of two (2) feet or less in height, all stumps, roots, etc., within the limits of the slopes shall be grubbed and removed and bunched or piled along edge of clearing, or otherwise disposed of as directed by the Engineer. Piles of stumps shall not be less than one hundred (100) feet apart. Wherever possible, these piles of stumps and roots shall be burned or otherwise disposed of. Where stumps are of such size that they cannot be readily handled, they shall be broken up. In swampy sections or elsewhere, if so directed by the Engineer, grubbing with explosives will not be permitted.

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

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 compactness as the surrounding subgrade.

All grubbing shall be done a satisfactory distance ahead of the grading operations.

2.03 Method of Measurement: Grubbing will be measured by the acre and the quantity to be paid for will be determined by the the measurement of the area actually grubbed as required by the Engineer.

2.04 Basis of Payment: This work shall be paid for at the contract unit price bid for grubbing, which price shall include all material, tools, appliances and machinery, labor and incidentals necessary to satisfactorily do the work.

ITEM 3. DRAINAGE EXCAVATION

3.01 Description: Drainage ditches shall be constructed where shown on the plans or as ordered by the Engineer in writing. Drainage excavations shall be interpreted to mean: inlet and outlet ditches to structures and roadway, changes in channels of streams, berm ditches, ditches parallel to or adjacent to roadway, and hand ditches draining borrow pits, but beyond the limits of the roadway section as constructed, whether the excavation is dry or wet, and providing for the disposition of the material. All other ditches shall be paid for under common excavation. Lines, grades and cross-sections for drainage ditches will be given by the Engineer.

3.02 Construction Methods: The Contractor will be required to excavate the drainage ditches before the pavement is laid and in general at the time the rough grading is done. No deviation from alignment, grade or section, will be allowed except by written consent of the Engineer. All roots, stumps and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade, and shape of the section shown. The Contractor shall dispose of the excavated material as directed by the Engineer, and he may be directed to place the topsoil on one side of the ditch and the subsoil on the other. The material excavated from all ditches and channel changes shall be placed in the embankments and berms, or used for widening the same, as directed by the Engineer, and it is thoroughly understood that the price bid per cubic yard for drainage ditches and channel changes shall cover all cost of properly placing same in the embankment and berms. No excavation, or spoil, from a ditch shall be deposited or left within three (3) feet of the edge of ditch, unless otherwise shown on the plans or directed by the Engineer in writing. The Contractor shall maintain and keep open and free from earth, sticks and other debris all ditches dug by him, during the period he is to maintain the road.

3.03 Method of Measurement: Excavation from drainage ditches will be measured in its original position by cross-sectioning and computing by the average end area method, to ascertain the amount of material removed.

3.04 Basis of Payment: This item will be paid for at the contract unit price per cubic yard for "Drainage Excavation," which price shall include all material, tools, appliances and machinery, labor and incidentals necessary to satisfactorily complete the work.

ITEM 4. ROADWAY EXCAVATION

4.01 Description: Roadway excavation shall include all excavation within the limits of the typical cross-section, forming embankments, compacting same, shaping and sloping, the removal and proper disposal of hedgerows, fences, pipes, walls, steps and all existing drainage structures where required by the Engineer, within the limits of the right of way, other than structures shown as a pay item under Items 130 and 135.

All wooden culverts and bridges to side roads or private drives shall be removed where improvements are to be made and shall be immediately replaced after the improvements have been made, as required by the Engineer. The cost of removing and replacing these structures shall be included in the price bid on "excavation" and "borrow."

The Contractor will be required to remove and replace pipe culverts to side roads and private drives, where required by the Engineer. This work shall be paid for as "Roadway Excavation" and the quantity to be paid for will be the volume displaced by the structure plus the material actually removed between vertical planes, one (1) foot outside and parallel to the outside lines of the structure.

4.02 Construction Methods: 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 excavation material shall be wasted without permission 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, which material shall be classified as borrow if beyond the limits of the typical cross-section. 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. Drainage and side ditches shall always be excavated for not less than four thousand (4000) feet ahead of roadway surfacing. Side ditches or gutters emptying from cuts to embankments shall be constructed so as to avoid damage to embankments by erosion. In widened cuts, outside of the slope stakes and within the limits of the right-of-way, the bottom of the widened cuts shall not be lower than the elevation of the adjacent subgrade unless permitted by the Engineer in writing. Under no conditions will holes be gouged or dug in back slopes or in embankments to obtain material for covering concrete roads, or building shoulders.

In cuts, any material excavated by the Contractor beyond the limits of the typical cross-section of the roadway where no material is needed for borrow, shall be at the Contractor's expense and will not be paid for.

Excavation shall include the removal and satisfactory disposal of all material taken from within the limits of the typical cross-section of the roadway in conformity with the plans and profile, true to the lines and grades given. Also side ditches and off-take ditches except as specified under "Drainage Ditches."

Sod, grass, weeds, and other objectionable matter shall be removed from within the limits of slope stakes on fills of two (2) feet depth and less, but the Contractor shall not receive any compensation for this work, it being understood that his com-

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pensation will be covered by the increased amount of material going into the fills, due to the removal of said sod, grass, weeds, or other objectionable matter, which material is fully covered by the unit prices for regular excavation or borrow.

Fences or pipes which are to be re-used shall be removed with care and piled or disposed of in a manner acceptable to the Engineer.

Weep holes not less than three (3) inches in diameter and not more than ten (10) feet apart shall be provided in all abutments, retaining walls and culverts. Their outlet ends shall be placed just above the groundline in front of abutments and retaining walls. In culverts they shall be placed approximately six (6) inches above the flow line. The outside ends of weep holes shall be covered by the Contractor with at least two (2) cubic feet of clean, broken stone or gravel, so placed as to allow free drainage but at the same time prevent the fill from washing out. From approximately six (6) inches below the bottom of the outside ends of the weep holes a column of clean, broken stone or gravel, at least one (1) foot square, shall be carried up, by the Contractor, 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 the Contractor 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.

For foundations through a hard material exposed to erosion, the backfill around piers and in front of abutments and wings may be ordered by the Engineer to be of stone fill or lean concrete, in which case unless otherwise provided, this backfill shall be paid for as "Extra Work."

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 twenty-one (21) days.

4.03 Overbreaks and Slides: Overbreaks shall be interpreted to mean the breaking back, or caving in, of any material back of the actual general slope line of the cut, as finally approved by the Engineer. This shall apply to both the top and bottom of the cut. Overbreaks may be due to heavy blasting, or to other causes. Where overbreaks occur, the Contractor shall remove same at his own expense.

Slides shall be interpreted to mean the unavoidable sliding of material along a smooth, well defined seam. They are not likely to occur when the blasting and excavating are carefully performed, but in seamy formations the vibrations due to heavy blasting will greatly augment the possibility of a slide. The Contractor shall, therefore, take every possible precaution when working in such formations to prevent the material from sliding, and he may be required to cut a ditch or trench above the upper slope line so as to drain the surface water away from the seams, which work shall be paid for at the regular unit price for drainage ditch excavation.

In heavy earth or clay cuts which are taken out by a steam shovel, the possibility of slides and overbreaks may be greatly reduced by dressing the slopes to a uniform ratio, as 1 to 1, $\frac{3}{4}$ to 1, or $\frac{1}{2}$ to 1, according to the nature of the material, and in cases which in the opinion of the Engineer are likely to break back or slide, the

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Contractor shall dress his work to the required slope. All slides, which in the opinion of the Engineer were unavoidable, and which bear no evidence of heavy blasting shall be classified as "Common Excavation" and paid for accordingly, but the Contractor shall remove at his own expense any slide which bears evidence of careless work or heavy blasting.

The width of the roadbed in cuts is shown by a typical section in the plans. The Contractor will not be paid for excavating cuts of a greater width than that shown by the typical section, unless same be staked off as a borrow pit or as a widened curve.

When the use of a dredge or drag line is permitted or stipulated, and when the Engineer deems it necessary, the Contractor will furnish one (1) or more men to act as spotters on the embankment. These men are to flag the dredge or drag line operator and supervise the placing of material in the embankment.

4.04 Lines and Grades: The Contractor shall follow the marks indicating the lines and grades as set by the Engineer, but if, for any reason, it shall appear to the Contractor that errors have been made in setting such marks, he shall report the same to the Engineer and await his advice before proceeding.

No payment will be made for work which may have been done beyond the lines and directions given by the Engineer, except as stated under "Overbreaks and Slides."

4.05 Embankments: Embankments shall be formed according to the classifications outlined under paragraphs 4.05-A, 4.05-B, and 4.05-C below, except in cases where the plans call for Dredged Embankment or Hydraulic Embankment, in which case Item 8, Dredged Embankment, or Item 9, Hydraulic Embankment, as the case may be, will apply.

Where draglines are used as permitted in paragraphs below, the layers shall be put up for the entire length of fill, except where fills are more than 2,000 feet in length, the layers may be placed in 2,000 foot sections. Each layer shall be leveled off with a tractor and blade, the blade to be not less than eight feet in length.

Stumps, trees, rubbish, sod, or other unsuitable material or substances shall not be placed in the embankment. When embankments are to be made on a hill side, sloping more than thirty (30) degrees from the horizontal, the slope of the original ground on which the embankment is to be placed shall be ploughed deeply or cut into steps before the filling is commenced. 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 negligent work on the part of the Contractor, and not attributable to the unavoidable movement of the natural ground upon which the embankment is made. Embankments over and around pipes, culverts, arches and bridges shall be of selected materials, placed and thoroughly tamped, puddled and compacted as directed by the Engineer, so as to avoid undue strain to the structure. Stone columns shall be brought up from weep holes as provided for in Bridge Specifications under "Back-filling." All traffic over the work during the construction shall be distributed so as to cover the entire surface of each layer.

No trestles will be allowed in the construction of embankments without written permission from the Engineer. When their use is permitted no portion of the trestle shall come under any part of the proposed location of pavement, including widened curves. Trestles so located may be left in place, provided they are cut two (2) feet below subgrade.

4.05-A Embankments Constructed Preparatory to the Laying of Concrete Pavement:

Embankments constructed under this classification shall be formed of suitable material placed in successive leveled layers of not more than twelve (12) inches in depth for the full width of the cross-section. These twelve (12) inch layers may be placed in two (2) sections provided the next twelve (12) inch section above, breaks joints by not less than four (4) feet. Each layer shall be thoroughly rolled with a ten (10) ton Power driven Roller. Each layer should be thoroughly rolled in a manner satisfactory to the Engineer.

The use of drag lines will not be permitted on the construction of any embankment of three (3) feet in height and under except where embankment consists of widening existing roadbed for the construction of shoulders. In no case will drag lines be permitted to construct any embankment with the machine or any portion of it resting on, or the weight of same being transferred to, the paving slab. 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.

Drag lines will be permitted on the construction of embankment of over three (3) feet in height, the embankment to be placed in twelve (12) inch layers, as specified, and pressure jetted as per Item 19 of these specifications.

4.05-B Embankments Constructed Preparatory to the Laying of Surface Treatment:

Embankments constructed under this classification will meet the requirements as specified in Paragraph 4.05-A, except that no pressure jetting will be required, the entire height of fill to be placed in twelve (12) inch layers and each layer rolled.

It is further provided that, due to the character or condition of the soil or method of construction, it may be found impracticable to roll some sections of embankment. Therefore, the rolling of the embankments in twelve (12) inch layers will be bid on as a separate item. Item 4.20 Rolled Embankments, will apply.

4.05-C Embankments Constructed Preparatory to the Laying of Shell, Gravel or Crushed Stone Surfacing: Embankments constructed under this classification will meet the requirements as specified in Paragraph 4.05-A, except that no rolling or pressure jetting will be required.

The requirements of Paragraph 4.05-C shall also apply to projects let for grading, unless otherwise specified in the Special Provisions.

4.06 Disposal of Surplus Material: All surplus excavation and waste material shall be used uniformly to widen embankments or flatten the slopes, or deposited in such other places and for such purposes as the Engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the Engineer.

4.07 Subgrade: The subgrade shall be properly shaped, rolled and uniformly and firmly 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

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by rolling the entire area with a power-driven roller weighing from four (4) to ten (10) tons or a power-driven roller weighing not less than one hundred seventy (170) pounds per inch width of tread. Subgrade for macadams shall be rolled with a ten (10) ton three-wheel, power-driven roller, wherever possible. Any portion inaccessible to the roller shall be compacted thoroughly with hand tampers weighing not less than fifty (50) pounds, the bearing or tamping face of which shall not exceed one hundred (100) square inches in area. All unsuitable soft and yielding material which will not compact readily shall be removed and back-filled with suitable material and the subgrade shall again be rolled until no depressions develop. Under no conditions will material for back-fill be taken from embankments to a greater depth than sub-grade elevations or from holes dug in the back slopes, this excavating and back-filling to be paid for at the unit price bid per cubic yard for common excavation. Should sufficient time elapse between the rough grading and the laying of pavement to allow the earth to become baked and hardened, whether traffic has been allowed on the subgrade or not, the surface shall be rescarified and rerolled. Frost crystals or mud caused by freezing and thawing shall be removed before placing any roadway material on the subgrade, and shall be replaced with suitable material.

The subgrade must be in a condition so that it will drain readily. In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade, and if ruts are formed, the subgrade shall be sacrificed and rolled, or thoroughly tamped. The subgrade shall be planked to prevent further rutting, if necessary in the opinion of the Engineer.

The subgrade shall be in final condition for receiving roadway materials for a distance of at least five hundred (500) feet in advance of the placing of the roadway materials, forms, etc. No roadway materials, forms, etc., shall be placed until the subgrade has been approved. In the case of concrete pavements and concrete base course pavements, no materials shall be allowed under subgrade.

If the roadway of the present road is of macadam or and conforms approximately to the grade of the proposed roadway, then the macadam road shall be sacrificed to a depth of six (6) inches or as directed by the Engineer and to the width of the proposed surfacing and shaped to conform to the proposed section uniformly compacted.

If the roadway of the present road is of gravel or follows the traveled way of an old road or a furrowed field, then the surface which is beneath the new surfacing shall be thoroughly ploughed and scarified to a depth of six (6) inches below the original surface or as directed by the Engineer, after which it shall be reshaped and rolled as hereinbefore specified. This is to secure a subgrade of uniform rigidity.

The subgrade will be considered as that portion of the highway on which the surfacing rests, except that for brick, concrete, or hard surface roads having a concrete base, the subgrade shall be interpreted to mean the area lying between points one (1) foot outside that portion on which the surfacing rests. No payment for excavation will be allowed for this additional width.

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.

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When the road is to be surfaced with gravel, it shall be graded, according to the specifications, true to the line and grade shown on the plans.

The subgrade shall be free from boulders, loose stones, muck, quicksand, and all vegetable matter, or other material that, in the opinion of the Engineer, would prove detrimental to the road. All large, loose rocks or boulders extending close to the surface of the subgrade shall be broken off twelve (12) inches below the surface of the subgrade and removed.

On all types of construction, the subgrade and the roadway shall be super-elevated and widened on curves as directed by the Engineer in accordance with the standard plans.

4.08 Shoulders: Shoulders of the width and shape shown on the plans shall be constructed of approved material. They shall be carefully machined and dressed after the road has been completed. They shall be brought true to the cross-section of the finished road, and be free from dips, bumps or irregularities in alignment.

The shoulders shall be graded so that they will drain properly and so that no water will lie along the edge of the completed pavement, surfacing, or in the adjacent ditches. Progress on this shoulder and ditch work shall not be more than four thousand (4,000) feet behind the last laid pavement or surfacing, except in the case of concrete pavements where the fourteen (14) curing days have not elapsed or where an industrial system is used. The cost of constructing shoulders is included in the unit price bid for "excavation" or "borrow," as the case may be, and no additional payment will be made for the construction of same.

4.09 Fine Grading: In the event the surfacing is let under a separate contract from the rough grading, the price bid for excavation shall be the full compensation for the preparation and completion of the subgrade, shoulders, and ditches in accordance with the specifications and plans provided.

4.10 Methods of Measurement: All excavation will be measured in its original position by cross-sectioning and computed by the average end area method to ascertain the amount of material removed. Embankment measurement will not be allowed except by written permission of the Engineer.

Measurements of material excavated to place structures will be made by the Engineer, and the quantity of this material placed in the embankment will be considered when computing the quantity of overhaul on excavation and borrow.

No direct payment will be made for excavating and disposing of the materials required to be moved, in order to build the structure, as the cost of this work shall be included in the prices bid for the construction of the structure.

Excavation will be allowed for all existing drainage structures removed and the quantity of excavation to be paid for will be the volume displaced by the structure plus the material actually removed between vertical planes, one (1) foot outside and parallel to the outside lines of the structure.

4.11 Basis of Payment: All excavation will be computed and paid for at the contract unit price per cubic yard for "Roadway Excavation," which price shall include the removal of all obstructions as specified under "Roadway Excavation" within the limits of the right of way, the formation of embankments, refilling around structures, and the disposal of all surface material, preparation of subgrade, shoulders, ditches, and fine grading.

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ITEM 4.20. ROLLING EMBANKMENTS

4.21 Description: Rolling embankments shall include the rolling of all embankments as specified under Paragraph 4.05-B of these specifications.

4.22 Equipment: The roller to be used shall be a ten (10) ton Power-driven Roller.

4.23 Method of Measurement: The yardage to be paid for shall be the number of cubic yards accepted rolled embankment measured in place after rolling and placing of embankment have been completed.

4.24 Basis of Payment: This item shall be paid for at the unit price bid per cubic yard for rolling embankments, which price shall be full compensation for furnishing all materials, equipment, tools, labor and all work incidental to compliance with the plans and specifications.

Attention is called to the fact that this pay item for rolling embankments applies only to embankments constructed under Paragraph 4.05-B "Embankments Constructed Preparatory to Laying of Surface Treatment." Payment will be made under Item 4.20 "Rolling Embankments" (per cubic yard).

ITEM 5. BORROW

5.01 Description: When sufficient quantities of suitable materials are not available from the roadway excavation to properly form the embankments, subgrade, and shoulders of the road, such additional material must be obtained from borrow pits furnished by the Highway Commission and located by the Engineer.

5.02 Construction Methods: Preference shall be given the widening of cuts on the inside of curves beyond the limits of the typical cross-section. If the Contractor places more "Borrow" than is required, causing a waste of "Excavation" the amount of such waste shall be deducted from the "Borrow" as measured in the "Borrow Pit". Borrow Pits shall be staked out and cross-sectioned before the Contractor begins work therein. No payment whatever will be allowed the Contractor for any material excavated from Borrow Pits, or elsewhere, prior to the staking out and cross-sectioning of the work by the Engineer. All Borrow Pits shall be so excavated, neatly trimmed, and left in such shape as to admit of accurate measurement after the excavation of the same is completed. Borrow Pits shall also be sufficiently drained so that no water will collect or stand therein.

5.03 Method of Measurement: "Borrow" shall be computed by the method of average end areas from cross-sections obtained before the original ground has been disturbed and immediately after final dressing up of the Borrow Pits. Embankment measurement will not be allowed except by written permission of the Engineer.

5.04 Basis of Payment: All borrow will be paid for at the contract unit price per cubic yard for "Borrow," which shall include the removal and placing of all material in its final position in the highway, and the use of all equipment, tools, labor and work incidental thereto, except that clearing and grubbing of Borrow Pits will be paid for at the contract unit prices per acre for "Clearing" and for "Grubbing."

ITEM 6. OVERHAUL ON EXCAVATION AND BORROW

6.01 Description: Overhaul on Excavation and Borrow shall be considered when it is necessary to haul material a greater distance than the free haul limit of one thousand (1000) feet.

6.02 Method of Measurement: No payment shall be made for hauling material when the length of haul does not exceed the limit of free-haul, which shall be one thousand (1000) feet.

The limits of free haul shall be determined by fixing on the profile two points—one on each side of the neutral grade point, one in the excavation, and the other in embankment—such that the distance between them shall equal the specified free-haul limit and such that the included quantities of excavation and embankment balance. All haul of material beyond the free-haul limit shall be estimated and paid for on the basis of the following method of computation, viz:

All material within this limit of free-haul shall be eliminated from further consideration.

The distance between the center of gravity of the remaining mass of excavation and the center of gravity of the resulting embankment, less the limit of free-haul as above described, shall be the overhaul distance; and the quantity of overhaul shall be computed by the mass-diagram method in units of one (1) cubic yard moved one hundred (100) feet, which units shall be designated as "station-yards."

In case material is obtained from borrow pits along the embankment, and runways constructed, the haul shall be determined by the distance the team, or vehicle, necessarily travels. The overhaul shall be determined by multiplying the number of cubic yards hauled by one-half of the round trip distance made by the team, or vehicle, less the free-haul distance. The runways shall be established by the Engineer.

6.03 Basis of Payment: "Overhaul" shall be paid for at the contract unit price per station-yard, which price shall include all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

ITEM 7. STRIPPING

7.01 Description: This item shall consist of the excavation of the overburden covering the clay or other deposit of which the embankment in swamp or marsh projects is to be constructed. Dry land stripping of gravel or other material pits is not included. This overburden may be composed of stumps, roots, decaying logs, humus, colloidal matter or any material not satisfactory for incorporation in the embankment. The Resident Engineer will decide what material shall be wasted as stripping, and what material is satisfactory for incorporation in the embankment, but a general distinction is that stripping shall be composed of such material from the dredged canal as will decay or otherwise produce unsatisfactory subsidence of the embankment, while the material to be classified as borrow shall be material for which the coefficient of shrinkage has been determined. The stripped material shall be disposed of as indicated on the plans or as directed by the Engineer.

7.02 Method of Measurement: Stripping shall be measured in its original position by the method of average end areas. Original sections will be taken at intervals along the center line not to exceed half stations of fifty (50) feet to determine the quantity of material removed, and shall include such width as is staked out, or as otherwise provided in the "Special Provisions" under the item of stripping.

7.03 Basis of Payment: This item shall be paid for at the contract unit price per cubic yard for "Stripping," which price shall be full compensation for the furnishing of all materials, equipment, tools, labor and incidental work necessary to complete the work in accordance with the plans and specifications.

ITEM 8. DREDGED EMBANKMENT

8.01 Description: This item shall consist of dredging and excavating acceptable material from designated canals and placing the material as ordered in embankments, dressing and completing the embankments in accordance with the specifications and in conformity with the lines, grades and typical cross-section shown on the plans.

8.02 Equipment: The dredge to be used shall meet the approval of the Engineer and 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 unless authorized by the Engineer.

8.03 Material: Material excavated from the canal and to be used in the embankment, must be free from all decayed matter, roots, stumps, logs or other material considered unfit for incorporation in the embankment. Material considered unfit shall be placed on the waste bank side of the canal or the side farthest from the roadway.

8.04 Constructing Embankment: 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 or 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.

When the Engineer deems it necessary, and his request is made in writing, the Contractor shall furnish one (1) or more men to act as spotters on the embankment. These men are to flag the dredge operator and supervise the placing of material in the embankment.

If the difference in elevation of the existing embankment and that of the completed embankment is greater than two and one-half ($2\frac{1}{2}$) feet, the embankment shall be constructed into two (2) or more layers. The quantity of the first layer being determined by the depth of the canal necessary to float the dredge. New material shall be placed in two (2) or more successive operations at least thirty (30) days apart. In the event of severe rainfall or if the material first placed shall not have dried out sufficiently to effect stabilization, the period between operations shall be increased upon orders from the Engineer, but not to exceed sixty (60) days. Material for the second and subsequent layers shall be taken from the bottom of the canal so as to secure as high a proportion of clay or other stable material as possible.

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

8.05 Cross-Section of Canal: The depth of canal on the embankment side shall be only sufficient to float the dredge. This 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.

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8.06 **Berm:** The width of berm shall be standard as shown on the plans.

8.07 **Corduroy:** Where shown on the plans or directed by the Engineer, the embankment shall be constructed on a corduroy mat. This mat shall be constructed after an approved design and shall consist generally of poles not less than six inches in diameter at the smaller end placed parallel with the roadway on five-foot centers. On top of these sleepers will be placed an intermediate layer of poles of not less than two and one-half inches in diameter at the smaller end, and as close together as possible, to form the corduroy. On top of the corduroy and at right angles to it will be placed longitudinal poles parallel with and of the same size as the sleepers. These poles will be called runners and they will be wired through the corduroy to the sleepers by not less than five passes of No. 8 galvanized wire or the equivalent, on five foot centers, or closer if directed by the Engineer. The width of the corduroy shall be equal to or wider than the base of the fill. The basis of payment for corduroy will be covered by special provisions.

8.08 **Placing Material on Corduroy:** Where corduroy is used, the dredged material shall be so placed as not to damage or disarrange the corduroy. Dropping of material on the mat from a greater height than two feet, and unbalanced loading of the mat will not be permitted.

8.09 **Dressing Embankment:** When the embankment is completed it shall be carefully dressed on top to the satisfaction of the Engineer before any surfacing is placed, and an excessive amount of surfacing required by inequalities of the subgrade will not be allowed on the final estimate.

8.10 **Sodding:** The shoulders and slopes of the embankment, in all cases where the embankment is over two feet high on the slope, shall be sodded with bermuda or other suitable growth, by setting live roots on twelve inch centers each way, and at least 75% of any given area must be alive and growing before the work will be considered acceptable. The cost of sodding shall be included in the contract price for other items, and will not be considered a separate pay item, unless otherwise specified.

8.11 **Method of Measurement:** Canal measurement of the original space occupied by the material, computed by the method of average end areas, shall determine the amount of the cubic yards removed. Sections will be taken at intervals along the center line, not to exceed half stations of fifty (50) feet. This measurement to be made not more than forty-eight (48) hours after excavation and on progress estimates, the payment will not cover yardage closer than two hundred (200) feet in the rear of the dredge.

8.12 **Basis of Payment:** This work, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Dredged Embankment," which price shall be full compensation for all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

ITEM 9. HYDRAULIC EMBANKMENT

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

9.02 Permits: The Contractor must provide himself with the necessary permits from the Federal authorities to operate dredges and other floating equipment in open or other waters under their control, unless otherwise authorized by the Engineer, or specifically shown on plans. Failure to secure such permits will not operate to release the Contractor or his bonding company from responsibility for completion of the work within the time limit.

9.03 Material: Material pumped into the embankment must be free from all humus, colloidal matter, or any material not satisfactory for incorporation in the embankment. The Engineer shall decide what materials may be used for construction purposes.

9.04 Construction Methods: Hydraulic dredge or dredges stationed at points by the Contractor unless otherwise specified, will pump materials found in the lakes, rivers or other waters, consisting of sand, clay or shells through a pipe line not less than fifteen (15) inches in diameter into the embankment. No material for the hydraulic embankment shall be obtained from sources closer than seven hundred fifty (750) feet from the location of the proposed roadway. The Engineer shall have authority to reject materials encountered at the location or successive locations of the hydraulic dredge and considered by him to be unsatisfactory for use in the embankment. Such materials shall be stripped at the Contractor's expense and no payment therefor will be made. The embankment shall be composed entirely of pumped in materials and any muck brought to the top of the embankment shall be removed by the Contractor at his own expense and satisfactory material substituted therefor. The discharge of pumped materials shall not be effected at right-angles to the center-line of the roadway or any existing levees. The discharge pipe, for at least fifty (50) feet must be laid parallel to the center-line of the highway. 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.

9.05 Method of Measurement: The material used in the construction of the embankment shall be measured complete in place as shown by the typical cross-section sheet of the plans. No material placed outside of the typical cross-section shall be paid for unless otherwise specified.

9.06 Basis of Payment: The contract price per cubic yard for Hydraulic Embankment shall be payment in full for the placing of the material within the pay sec-

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tions as shown by typical cross-section on the plans and for dressing the side slopes of the embankment, either to the slope shown or to a flatter slope, if allowed by the Engineer, together with the furnishing of all material, equipment, tools, labor and work incidental to compliance with the plans and specifications.

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ITEM 10. REBUILT FENCE

10.01 Description: This item shall consist of taking down, moving back and rebuilding existing fence as indicated on the plans and as directed by the Engineer.

10.02 Methods of Construction: 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 by allowing cattle, horses, mules and other animals to roam through gaps left by his workmen.

10.03 Method of Measurement: This item shall be measured by the station (100 linear feet) of "Rebuilt Fence" complete in place.

10.04 Basis of Payment: "Rebuilt Fence" shall be paid for at the contract unit price per station (100 linear feet), which price shall be full compensation for all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

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ITEM 11. NEW BARBED WIRE FENCE

11.01 Description: This item shall consist of the furnishing and construction of a fence consisting of four (4) strands of new barbed wire supported by wooden posts and securely nailed to the posts with wire staples. The posts shall be spaced ten (10) feet center to center. The barbed wire fence shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

11.02 Barbed Wire and Staples: The barbed wire shall be four (4) point hog wire and shall consist of strands of tough annealed 12½ U. S. Standard gauge heavily galvanized.

Staples shall be made of galvanized steel wire and shall be not less than 1¼ inches long.

11.03 Wooden Posts and Braces: Creosoted posts shall be air-seasoned yellow pine impregnated by an empty cell process so as to retain at least five (5) pounds of preservative, Grade 1 Creosote Oil per cubic foot of material and shall be sawn halves from round posts which shall be not less than four and one-half (4½) inches diameter in any place. Cypress, catalpa or white oak posts shall be of sound timber 4"x 6", or round posts of not less than four (4) inches in diameter, the bottom two and one-half (2½) feet to be dipped in hot tar pitch. All posts, except gate posts, shall be sawed off square at both ends and shall be six and one-half (6½) feet in length and set in the ground two (2) feet. If round posts are used, they shall be peeled and trimmed of all knots and knobs and shall be straight and smooth.

The braces shall be of sound timber 4" x 4" and shall be placed at angles, corners, gates, at the beginning and end of fence and on straight sections and shall not be more than one thousand (1000) feet apart.

Construction Methods

11.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The barbed wire shall be nailed to the posts with at least one 1¼ inch staple for each strand and as many additional staples as required to make a secure and workmanlike fence.

11.05 Method of Measurement: This item shall be measured by the station (100 linear feet) of "New Barbed Wire Fence."

11.06 Basis of Payment: This item shall be paid for at the contract unit price per station (100 linear feet) which price shall include all materials, equipment, tools, labor and incidentals necessary to complete the fence according to the plans and specifications.

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ITEM 11-B. NEW FENCE POSTS

11.01-B Description: This item consists of the furnishing and installing of new fence posts where required in the reconstruction of old fence. The posts shall meet the requirements of posts for "New Barbed Wire Fence" under Paragraph 11.03.

11.02-B Basis of Payment: This item shall be paid for at the contract unit price bid under Item 11-B, which price shall include the furnishing and installing of the post, complete in place, in the fence.

ITEM 12. COMBINATION MESH AND BARBED WIRE FENCE

12.01 Description: This item shall consist of the furnishing and construction of a fence consisting of three (3) strands of new barbed wire and one (1) section of new mesh galvanized wire, supported by wooden posts and securely nailed to the posts with wire staples. The posts shall be spaced ten (10) feet center to center. The combination mesh and barbed wire fence shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

12.02 Barbed Wire, Mesh Wire and Staples: The barbed wire shall be four (4) point hog wire and shall consist of strands of tough annealed 12½ U. S. Standard gauge heavily galvanized.

The mesh wire shall be constructed on the hinged joint principle. The stays or uprights are separate pieces of wire which connect with the horizontal or strand bars and are wrapped securely around the strand, forming a complete joint or lock. Mesh wire to be twenty-six (26) inches high, galvanized and shall not weigh less than six (6) pounds per linear rod. All wire to be basic open hearth steel.

Staples shall be made of galvanized steel wire and shall not be less than 1¼ inches long.

12.03 Wooden Posts and Braces: Creosoted posts shall be air-seasoned yellow pine impregnated by an empty cell process so as to retain at least five (5) pounds of preservative, Grade 1 Creosote Oil per cubic foot of material and shall be sawn halves from round posts which shall be not less than four and one-half (4½) inches diameter in any place. Cypress, catalpa or white oak posts shall be of sound timber 4" x 6", or round posts of not less than four (4) inches in diameter, the bottom two and one-half (2½) feet to be dipped in hot tar pitch. All posts, except gate posts, shall be sawed off square at both ends and shall be six and one-half (6½) feet in length and set in the ground two (2) feet. If round posts are used, they shall be peeled and trimmed of all knots and knobs and shall be straight and smooth.

The braces shall be sound timber 4" x 4" and shall be placed at angles, corners, gates, at the beginning and end of fence and on straight sections and shall not be more than one thousand (1,000) feet apart.

Construction Methods

12.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The barbed wire and mesh wire shall be nailed to the posts with one staple for each horizontal strand and as many additional staples as required to make a secure and workmanlike fence.

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12.05 Method of Measurement: This item shall be measured by the station (100 linear feet) of "Combination Mesh and Barbed Wire Fence."

12.06 Basis of Payment: This item will be paid for at the contract unit price per station (100 linear feet) which price shall include all materials, equipment, tools, labor and incidentals necessary to complete the fence according to the plans and specifications.

ITEM 13. SODDING

13.01 Description: This item shall consist of providing and planting approved live sod on all fills for protection against erosion, as directed by the Engineer when bids are requested. The sods shall be of suitable size, variety and character for the purpose selected and for the soil upon which it is to be planted, for vigorous and hardy growth, and approved by the Engineer.

13.02 Materials: The sods or tufts shall be of Bermuda grass or some other grass approved by the Engineer and native to the locality of the work, and shall be provided by the contractor and placed as directed.

13.03 Method of Construction: After the embankment has been completed in accordance with the plans and specifications, all fills of two (2) feet or over shall be sodded with turfs of suitable grass. A strip of sod shall be placed on the slope just underneath the shoulder line so as to form one continuous strip of turf about three (3) inches wide and, on the remainder of the slope and upon shoulders similar strips of sod three (3) inches wide shall be planted in continuous rows of twelve (12) inches, center to center. The area of shoulders and slopes to be sodded shall begin at the edge of the surface course and extend to the toe of the slope on each side of the embankment. Sodding shall be done at such times as the Engineer may direct and in such manner that the grass will at once take root.

13.04 Basis of Payment: Sod planted and accepted by the Engineer will be paid for at the contract unit price bid per station (one hundred (100) linear feet), of roadway sodded on both sides to the width required by the Engineer, which price shall be full compensation for furnishing and planting the sod, all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 14. PROJECT MARKERS

14.01 Description: This item shall consist of furnishing and erecting "Project Markers" on concrete posts at the points indicated on the plans, or as directed by the Engineer, and in accordance with the plans and specifications.

14.02 Materials: The posts shall be made out of class "AA" concrete as defined in Item No. 60 of Pamphlet "L" and reinforced as shown on plans. The markers are to be of material as indicated on the plans.

14.03 Construction: The posts shall be set at the points indicated and in the manner specified on the plans, or as directed by the Engineer. The tamping of the earth, in backfilling around the post, shall be done in layers, in order to secure the greatest degree of compaction possible.

14.04 Basis of Payment: This item will be paid for at the contract unit price each for "Project Markers" which price shall be full compensation for all material, equipment, tools, labor and incidentals necessary to complete the work.

ITEM 14.10. RIGHT-OF-WAY MARKERS

14.11 Description: This item shall consist of furnishing and erecting "Right-of-Way Markers" consisting of concrete posts, at the points indicated on the plans, or as directed by the Engineer, and in accordance with the plans and specifications.

14.12 Materials: The markers shall be made out of class "AA" Concrete as defined in Item No. 60 of Pamphlet "L" and reinforced as shown on plans.

14.13 Construction: The posts shall be set at the points indicated and in the manner specified on the plans, or as directed by the Engineer. The tamping of the earth, in backfilling around the posts, shall be done in layers in order to secure the greatest degree of compaction possible.

14.14 Basis of Payment: This item will be paid for at the contract unit price each for "Right-of-Way Markers" which price shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

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ITEM 15. SUB-BASE

15.01 Description: This item shall consist of special approved material, hauled, placed, and compacted, as more specifically provided for in the special provisions for the particular project.

15.02 Construction Methods: As provided for in the "Special Provisions."

15.03 Method of Measurement: As provided for in the "Special Provisions."

15.04 Basis of Payment: As provided for in the "Special Provisions."

15.10 Overhaul on Sub-Base: As provided for in the "Special Provisions."

15.11 Method of Measurement: As provided for in the "Special Provisions."

15.12 Basis of Payment: As provided for in the "Special Provisions."

ITEM 16. WIRE FABRIC GUARD RAIL

16.01 Description: This item shall consist of the furnishing and construction of a guard rail consisting of a woven steel wire fabric road guard supported by wooden posts and securely nailed to the posts with 2" wire staples. The posts shall be spaced eight (8) feet center to center. The guard rail shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

16.02 Wire Fabric: The wire fabric shall be made of No. 6 W. & M. gauge wire (.192 inch diameter). In no case shall the diameter of the wire vary more than 0.003 inch from the size specified. The wire shall be made of basic open hearth metal which before galvanizing shall conform to the Tentative Specification A82-21T of A. S. T. M. with subsequent revisions, and shall have a minimum tensile strength of 60,000 pounds per square inch of cross-sectional area of the galvanized wire. Tensile tests shall be made by taking a picket from roll of fabric, cutting to one foot length, and without previously straightening it, testing in a standard testing machine until the wire breaks. The pickets shall be interwoven to form a continuous fabric without knots or ties. The top and bottom ends of each pair of pickets shall be turned back over each other to form a knuckle. The wire shall be woven in the form of a uniform square mesh having parallel sides approximately two (2) inches apart. The standard width of fabric shall be twenty-four (24) inches. The fabric guard shall be galvanized after weaving and the weight of zinc coating per square foot of wire surface shall be not less than eight-tenths (0.8) oz. and shall withstand a minimum of four (4) one minute dips by the Preece Test. The zinc coating shall not crack, peel or flake during ordinary handling in shipment or erection of the guard.

The zinc used for coating shall be pure Virgin spelter conforming to A. S. T. M. Standard Specifications B-6.

Staples shall be made of No. 6 gauge galvanized wire and shall be not less than two (2) inches long.

16.03 Wooden Posts and Braces: The wooden posts and braces shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least eight (8) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. Intermediate posts shall be six inches by six inches by seven feet and set in the ground three feet six inches. The end posts shall be six inches by six inches by eight feet, set in the ground four feet six inches. The braces shall be of four inch by four inch sound timber placed at all end posts and at intervals of not more than two hundred (200) feet apart.

Construction Methods

16.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping.

The fabric shall be secured at intermediate posts on side of posts facing the road with five (5) two (2) inch No. 6 staples in each post, one (1) staple at top of fabric, one (1) at bottom and three evenly spaced between top and bottom staples. At each end post, fabric to be carried around three faces of the post and secured with five (5) staples in each face. The bottom edge of fabric shall be elevated above ground line as shown on the plans.

16.05 Method of Measurement: This item shall be measured by the linear foot of "Wire Fabric Guard-Rail," complete in place.

16.06 Basis of Payment: This item will be paid for at the contract unit price per linear foot for "Wire Fabric Guard-Rail" complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard-rail according to the plans and specifications.

ITEM 17. EXPANDED METAL GUARD RAIL

17.01 Description: This item shall consist of the furnishing and construction of a guard rail consisting of expanded metal supported by wooden posts and securely bolted to the posts by means of steel plates. The posts shall be spaced eight (8) feet center to center. The guard rail shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

17.02 Expanded Metal: The expanded metal guard rail shall be manufactured of ten gauge open hearth annealed sheets. The total area of steel in cross section of expanded guard rail shall not be less than 0.375 square inch per foot width. The minimum length of sheets (after expansion) shall not be less than 8' 4", and the minimum width of sheets (after expansion) shall not be less than twenty-four (24) inches. All sheets shall be galvanized (hot dipped) after expansion. Unless otherwise specified, the size of mesh shall be 5½" x 2¼". The sheets from which the guard rail is expanded shall have the following physical properties: Minimum Requirements: Elastic limit 25,000 lbs. per square inch; elongation 8"-18%; tensile strength 40,000 lbs. per square inch; stand being bent cold through 180 degrees flat on itself, without cracking on the outside of the bent portion.

17.03 Steel Plates and Bolts: Plates for securing guard rail to posts shall be at least four (4) inches wide, one-quarter (¼) inch thick and two (2) inches longer than the width of guard rail, slightly curved and galvanized. Bolts used with plates for securing guard rail to posts, shall be at least one-half (½) inch in diameter and of necessary length. All bolts, washers and nuts shall be galvanized.

17.04 Wooden Posts and Braces: The wooden posts and braces shall be creosoted, air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least eight (8) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. Intermediate posts shall be six inches by six inches by seven feet and set in the ground three feet six inches. The end posts shall be six inches by six inches by eight feet, set in the ground four feet six inches. The braces shall be of four inch by four inch sound timber placed at all end posts and at intervals of not more than two hundred (200) feet apart.

Construction Methods

17.05 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill and thoroughly compacted by tamping.

The expanded metal shall be secured to the intermediate and end posts on side of posts facing the road with a steel plate bolted to each post with four (4) one-half ($\frac{1}{2}$) inch bolts. The bottom edge of the expanded metal shall be elevated above ground line as shown on the plans.

17.06 Method of Measurement: This item shall be measured by the linear foot of "Expanded Metal Guard Rail," complete in place.

17.07 Basis of Payment: This item will be paid for at the contract unit price per linear foot for "Expanded Metal Guard Rail", complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard-rail according to the plans and specifications.

ITEM 17-A. RESILIFLEX GUARD RAIL WITH WOODEN POSTS

ITEM 17-AP. RESILIFLEX GUARD RAIL WITH CONCRETE POSTS

17.01-A Description: This item shall consist of furnishing and delivering the necessary posts, spring supports, rail plates and fastenings, and preparing, assembling, and setting the same, the painting of all metal portions and the necessary excavating and backfilling of the dimensions, in the manner, at the location, and to the lines, and grades shown on the plans, in these specifications or in the special provisions and proposal.

Materials

17.02-A Rail Plates: Rail Plates shall be made of Open Hearth semi-spring steel, properly tempered for toughness and high 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 and spring supports are produced shall be not less than 70,000 pounds per square inch. The dimension of the rail plate shall be not less than twelve gauge (.109 inch) by twelve inches.

17.03-A Spring Supports: Spring supports shall be constructed with three leaves, the outer leaf having hinged ends for connection with rail plates. Each leaf shall be made of Open Hearth Spring Steel, properly tempered after forming.

17.04-A Fastenings: $\frac{5}{8}$ "x12" hinge pins shall be furnished for connecting rail members to spring supports, and $\frac{5}{8}$ "x12" bolts with square washers shall be furnished for fastening spring supports to posts. For anchoring each end section of road guard to end post, three $\frac{3}{4}$ "x18" bolts with nuts and washers shall be furnished.

17.05-A Galvanizing: Each metal part of the guard rail, including fastenings, shall be galvanized by the hot dip method, and 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-tenths (1.4) 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.

17.06-A Painting: All metal parts of the guard rail, after erection, shall be painted with two coats of white lead and oil. Before applying the paint the metal surface shall be slightly etched with a diluted solution of vinegar, composed of one quart vinegar and two gallons of water. The paint shall conform to the following requirements:

Pigment—9 pounds of Sublimed White Lead, 3 pounds of Zinc Oxide.

Vehicle— $\frac{3}{4}$ gallon boiled Linseed Oil, $\frac{1}{4}$ gallon Raw Linseed Oil.

A variation of 5% either way from the quantities of pigment shown by the foregoing formulas will be allowed.

17.07-A Wooden Posts, Braces, and Anchors: The wooden posts, braces and anchors shall be creosoted, air-seasoned or artificially seasoned yellow pine, square edge, sound,

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and S4S, impregnated by an empty cell process so as to retain at least eight (8) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment in so far as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered 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. All posts shall be six inches by eight inches by six feet, set in the ground three feet five inches. The braces shall be of six inch by six inch sound timber placed at all end posts and at intermediate posts as shown on the plans.

17.08-A Concrete Posts and Braces: The concrete posts and braces shall meet the requirements of, and be constructed in accordance with the provisions of Item 17-P. Unless otherwise provided, the cost of furnishing the materials, constructing and erecting the posts and braces, shall be included in the contract unit price bid per linear foot for the guard rail complete in place. All concrete posts shall be six (6) inches by eight (8) inches by six (6) feet, set in the ground three (3) feet five (5) inches. Terminal and the first line post adjacent to terminal post shall be set in concrete as indicated on the plans. Braces shall be six (6) inches by six (6) inches placed as indicated on the plans.

Construction Method

17.09-A Erection: The posts shall be set plumb and firm, spaced and set in the ground as shown on the plans and to 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 heavy tamping during backfilling operations.

A spring support shall be provided at each post. The rail plates through the spring support shall be securely attached to the posts. The bottom edge of the rail shall be elevated above the ground line as shown on the plans. Before final completion, the posts shall be accurately aligned and re-aligned as may be required before final acceptance.

17.10-A Method of Measurement: The amount of resili-flex guard rail to be paid for will be the actual number of linear feet (measured from out to out of the end posts) as hereinbefore described, in place, completed and accepted.

17.11-A Basis of Payment: This item will be paid for at the contract unit price per linear foot for "Resili-flex Guard Rail" complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard rail according to the plans and specifications.

Payment will be made under:

- Item 17-A Resili-flex Guard Rail with creosoted wooden posts and braces (per linear foot).
- Item 17-AP Resili-flex Guard Rail with reinforced concrete posts and braces (per linear foot).

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ITEM 17-C. FLEX-BEAM GUARD RAIL WITH WOODEN POSTS

ITEM 17-CP. FLEX-BEAM GUARD RAIL WITH CONCRETE POSTS

17.01-C Description: This item consists of furnishing the necessary posts, corrugated plates and fastenings, and preparing, assembling, and erecting Flex-Beam guard rail. The guard rail shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

17.02-C Rails: The corrugated rail shall be made of open hearth high carbon steel (.85-1.05) having a tensile strength of not less than 100,000 pounds per square inch. The dimension of the plate being not less than ten (10) gauge (.141 inch) by eighteen (18) inches before corrugating.

17.03-C Fastenings and End Wings: "Support Bolts" shall be steel bolts one (1) inch in diameter and of the design and length indicated on the plans and shall be supplied with one (1) square nut and washer per bolt. "Rail Bolts" shall be steel bolts $\frac{3}{4}$ " x $1\frac{1}{2}$ " and of the design and type indicated on the plans and supplied with one (1) nut per bolt. End wings shall be of the design shown on the plans.

17.04-C Galvanizing: All metal parts of the guard rail, including fastenings shall be galvanized by the hot dip method, and shall have a continuous coating of prime virgin spelter so applied that it will adhere firmly to the surface of the metal. The rails shall have a coating of not less than one and four-tenths (1.4) ounces of zinc per square foot and the thickness of the coating shall be determined by its ability to withstand four (4) immersions in a testing solution of copper sulphate without showing any trace of metallic copper on the metal. The first three (3) immersions shall be for a period of one (1) minute each, and the fourth immersion for a period of one-half minute.

17.05-C Wooden Posts: The wooden posts shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least eight (8) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting and boring of the posts shall be done before treatment insofar as is practicable. All cuts and abrasions, after having been carefully trimmed, shall be covered with two (2) applications of a mixture of sixty (60) per cent creosoted oil and forty (40) per cent roofing pitch or brush coated with at least two (2) applications of hot creosote oil and covered with hot roofing pitch. All posts shall be six inches by eight inches by six feet, set in the ground three (3) feet five (5) inches.

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17.06-C Concrete Posts: The concrete posts shall meet the requirements of, and be constructed in accordance with the provisions of Item 17-P. Unless otherwise provided, the cost of furnishing the materials, constructing and erecting the posts, shall be included in the contract unit price bid per linear foot for the guard rail complete in place. All concrete posts shall be six (6) inches by eight (8) inches by six (6) feet, set in the ground three (3) feet five (5) inches.

17.07-C Painting: All metal parts of the guard rail, after erection, shall be painted with two coats of white lead and oil. Before applying the paint the metal surface shall be slightly etched with a diluted solution of vinegar, composed of one (1) quart of vinegar and two (2) gallons of water. The paint shall conform to the following requirements:

Pigment—9 pounds of Sublimed White Lead, 3 pounds of Zinc Oxide.
Vehicle— $\frac{3}{4}$ gallon of boiled Linseed Oil, $\frac{1}{4}$ gallon Raw Linseed Oil.

A variation of 5% either way from the quantities of pigment shown by the foregoing formulas will be allowed.

Construction Method

17.08-C Erection: The posts shall be set plumb and firm, spaced and set in the ground as shown on the plans and to lines and grades given. The post holes shall be back-filled, care being taken to select suitable material for the backfill and same shall be thoroughly compacted by constant heavy tamping during backfilling operation.

The rails shall be securely attached to the posts. The bottom edge of the rail shall be elevated above the ground line as shown on the plans. "End Wings" shall be provided and installed at all terminal posts. Before final completion, the posts shall be accurately aligned and re-aligned as may be required before final acceptance.

17.09-C Method of Measurement: The amount of Flex-Beam Guard Rail to be paid for will be the actual number of lineal feet (measured from out to out of the end posts) as herein before described, in place, completed and accepted.

17.10-C Basis of Payments: This item will be paid for at the contract unit price per linear foot for "Flex-Beam Guard Rail" complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard rail according to the plans and specifications.

Payments will be made under:

Item 17-C Flex-Beam Guard Rail with creosoted wooden posts (per linear foot).
Item 17-CP Flex-Beam Guard Rail with reinforced concrete posts (per linear foot).

ITEM 17-E. DURAGUARD GUARD RAIL WITH WOODEN POSTS

ITEM 17-EP. DURAGUARD GUARD RAIL WITH CONCRETE POSTS

17.01-E Description: This item consists of the furnishing of all necessary brackets, plates, posts, etc., and the preparing, assembling, and erecting of Duraguard Guard Rail. The guard rail shall be erected at the places indicated on the plans or as directed by the Engineer and shall be constructed in accordance with the detail plans and in conformity with the provisions of these specifications.

Materials

17.02-E 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; the dimensions of which shall not be less than twelve (12) gauge (.109 inch) by twelve (12) inches and shall be equipped with reinforced end connections.

17.03-E Brackets: Brackets shall be of the cushion type adaptable 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.

17.04-E Fastenings: $3\frac{7}{8}$ " Steel bolts of the designs and length indicated on the plans shall be furnished with two washer plates and one nut each for connecting the sheets to each bracket. One $\frac{5}{8}$ " steel bolt, with one steel bent washer, of the design and length indicated on the plans, shall be furnished with each bracket for fastening brackets to posts. For anchoring each end section of rail plate to end post, two $\frac{7}{8}$ " stud bolts with 7" of thread for adjustment including nuts and washers shall be furnished.

17.05-E Galvanizing: All metal parts of the guard rail, including brackets and fastenings, shall be galvanized by the hot dip method, and shall have a continuous coating of prime virgin spelter so applied that it will adhere firmly to surfaces of the metal. The rails and brackets shall have a coating of not less than one and four-tenths (1.4) 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.

17.06-E Wooden Posts, Braces and Anchors: The wooden posts, braces and anchors, shall be creosoted air-seasoned or artificially seasoned yellow pine, square edge, sound, and S4S, impregnated by an empty cell process so as to retain at least eight (8) pounds of preservative oil, American Wood Preservers' Association Creosote Oil, Grade 1, per cubic foot of material. All cutting, framing and boring of the posts shall be done before treatment insofar as is practicable. All cuts and abrasions after having been carefully trimmed shall be covered 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. All posts shall be six inches by eight inches by six feet, set in the ground three feet five inches. The braces shall be six inches by six inches sound timber placed at all end posts and at other points indicated on the plans.

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17.07-E Concrete Posts and Braces: The concrete posts and braces shall meet the requirements of, and be constructed in accordance with the provisions of Item 17-P. Unless otherwise provided, the cost of furnishing the materials, constructing and erecting the posts and braces shall be included in the contract unit price bid per linear foot for the guard rail complete in place. All concrete posts shall be six (6) inches by eight (8) inches by six (6) feet, set in the ground three (3) feet five (5) inches. Terminal and the first line post adjacent to terminal post shall be set in concrete as indicated on the plans. Braces shall be six (6) inches by six (6) inches placed as indicated on the plans.

17.08-E Painting: All metal parts of the guard rail, after erection, shall be painted with two coats of white lead and oil. Before applying the paint the metal surface shall be slightly etched with a diluted solution of vinegar; composed of one (1) quart of vinegar and two (2) gallons of water. The paint shall conform to the following requirements:

Pigment—9 pounds of Sublimed White Lead, 3 pounds of Zinc Oxide.
Vehicle— $\frac{3}{4}$ gallon boiled Linseed Oil, $\frac{1}{4}$ gallon raw Linseed Oil.

A variation of 5% either way from the quantity of pigment, shown by the foregoing formulas will be allowed.

Construction Method

17.09-E 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. The post holes shall be backfilled, care being taken to select suitable material for the backfill and same shall be thoroughly compacted by constant heavy tamping during backfilling operation.

The rails shall be securely attached to the posts. The bottom edge of the rail shall be elevated above the ground line as shown on the plans. Before final completion, the posts shall be accurately aligned and re-aligned as may be required before final acceptance.

17.10-E Method of Measurement: The amount of Duraguard Guard Rail to be paid for will be the actual number of lineal feet (measured from out to out of end posts) as hereinbefore described, in place, completed and accepted.

17.11-E Basis of Payment: This item will be paid for at the contract unit price per lineal foot for Duraguard Guard Rail complete in place, which price shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the guard rail according to plans and specifications.

Payment will be made under:

Item 17-E Duraguard Guard Rail with creosoted wooden posts and braces (per linear foot).

Item 17-EP Duraguard Guard Rail with reinforced concrete posts and braces (per linear foot).

ITEM 17-P. PRECAST CONCRETE GUARD RAIL POSTS AND BRACES

17.01-P Description: This item consists 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.

17.02-P Dimensions: 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.

17.03-P Materials: Reinforcing steel and concrete materials and their preparation and placing shall be in accordance with the requirements for reinforcing steel and class "AA" concrete as provided in Standard Specifications Pamphlet "L".

17.04-P 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.

17.05-P Finish: 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 post or brace brought to a smooth, neat appearance by rubbing off rough spots with a carborundum block.

17.06-P Curing: As soon as finished the posts and braces shall be covered with wet burlap and kept continually moist for a period of seven (7) days. No posts shall be set until at least two weeks old.

17.07-P Basis of Payment: Precast concrete posts and braces will be paid for at the contract unit price each, per post or brace, as the case may be, which price will include the cost of furnishing all materials, equipment, tools, labor and other items necessary for casting, curing and setting the post and braces, including excavating and backfilling and installing guard rail thereon as provided.

Payment will be made under Item No. 17-P, "Pre-Cast Concrete Guard Rail Posts and Braces" per each complete in place. (Posts and Braces counted separately).

ITEM 18. PLANK GATE

18.01 Description: This item shall consist of the furnishing and construction of a plank gate supported by wooden posts and consisting of six horizontal planks together with all vertical and diagonal pieces and braces, etc., necessary to comply with the detail plan for a Standard Plank Gate. All planks to be securely nailed together with 8-d wire nails. The plank gates shall be erected at the places indicated on the plans or as directed and shall be constructed in accordance with the detail plans and in conformity with the provisions of these Specifications.

Materials

18.02 Lumber and Posts: All lumber and posts shall be No. 1 common cypress S-4-S. The post shall be 6"x 8"x 8', the bottom three (3) feet of posts to be dipped in hot tar pitch. The top corners of posts and uprights on gate to be chamfered 2".

18.03 Hardware: The hinges shall be twelve (12) inch strap hinges and shall be fastened to the gate with 5/16" machine bolts with washers, and shall be nailed to the post with 20-d 1/4"x 4", chisel point, countersunk heads, light Hinge Nails. The chain for fastening the gate shall be galvanized iron "Well Chain" 48" long and secured to the post with three 2 1/2" staples.

Construction Methods

18.04 Erection: Posts shall be set vertically to the full depth shown on the plans and accurately spaced and lined. The post holes shall be back-filled, great care being used to select suitable material for the back-fill, and thoroughly compacted by tamping. The bottom edge of the gate shall be elevated above ground line as shown on the plans.

18.05 Basis of Payment: This item will be paid for at the contract price per gate, complete in place, which price shall be full compensation for furnishing all materials (including posts) equipment, tools, labor and incidentals necessary for the complete construction and erection of the gate and posts according to the plans and specifications.

ITEM 19. PRESSURE JETTING OF EMBANKMENT

19.01 Description: Pressure jetting of embankments shall be performed as directed by the Engineer, not less than thirty (30) days in advance of the laying of the pavement, or at such longer duration of time prior thereto as practical in accordance with following specifications covering same—

In general, all embankments over three (3) feet in height and fills, adjacent culverts and bridges will be pressure jetted.

19.02 Construction Methods: Compacting embankment materials by pressure jetting shall be performed where indicated on the plans or ordered by the Engineer. After the embankment has been brought up to the required height as described in Paragraph 4.05 of these Specifications, except that no rolling will be required. The surface shall be broken up by plowing to a sufficient depth to eliminate any crust which has formed. Pressure jetting of the embankment shall then be done by using a pipe line of not less than one and one-half inches (1½") in diameter, with the nozzle end terminating in a not less than three-quarter inch (¾") diameter nozzle. The pressure of the water at the nozzle when delivered shall not be less than seventy-five pounds (75 lbs.) per square inch. If necessary, the jet holes shall first be opened by spudding with a heavy iron bar, the holes to be placed as directed by the Engineer, and to be not farther than five feet apart on centers. Into these holes, the jet nozzle under full pressure, shall be inserted. As long as the fill will take water the jet shall remain in each hole. When the water begins to overflow from the top of the hole, or adjacent holes, the jet shall be forced down into the fill until it reaches a point within six inches of the bottom of the fill, where it shall remain as long as the embankment absorbs the water or until water oozes out of the sides of the fill. If a hole has to be abandoned temporarily because of leakage of water from the fill, the jet shall again be applied to it after the adjacent holes have been jetted. The jetting shall begin at the deepest and proceed towards the shallowest part of the embankment. Arching of the surface of the embankment shall be watched for continually and whenever found, the crust shall be broken. Jetting shall be continued until, in the opinion of the Engineer, the embankment is thoroughly settled and compacted. Not less than two weeks in advance of the paving, the Contractor shall backfill all holes with suitable material thoroughly saturated during the back-filling.

The unit price bid for jetting under this specification shall include any delay in the Contractor's operations caused by the performance of this work.

19.03 Method of Measurement: The yardage to be paid for shall be the number of cubic yards of accepted jetted embankment measured in place two weeks after the jetting has been completed. The length of fill paid for shall include the distance between end cross-sections holed and jetted, plus ten (10) feet.

19.04 Basis of Payment: This item shall be paid for at the unit price bid per cubic yard for pressure jetting of embankments, which price shall be full compensation for the furnishing of water, pumps, pipe lines and appurtenances, labor, equipment, tools, and all other incidentals necessary to complete the item.

Payment will be made under Item 19, Pressure Jetting of Embankments (per cubic yard.)

PAMPHLET "F"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

- Item 27. Clam Shell Surface Course.
- Item 28. Reef Sheel Surface Course.
- Item 29. Local Iron Ore Surface Course.
- Item 30. Sand Clay Gravel Surface Course.
- Item 31. Washed and Sand Clay Gravel Surface Course.
- Item 32. Washed Gravel Surface Course. ✓
- Item 33. Broken Stone Surface Course.
- Item. 34 Overhaul on Local Binder.

ITEM 27. CLAM SHELL SURFACE COURSE

27.01 Description: This surface, or wearing course shall be composed of shell and shall be constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness and cross-sections shown on the plans.

27.02 Material: 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 shall not exceed 3% by weight when dry.

27.03 Delivery of Shell: Should the contractor be delayed on account of non-delivery of shell to be furnished by the Commission, he shall not be entitled to claims for damages, but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission, to deliver shell as agreed.

When shell is to be shipped in, it will, unless otherwise specified, be furnished by the Commission, f. o. b. car siding, or barge landing, at such points as the Engineer and contractor may agree upon. Unless otherwise provided, the contractor shall unload cars and barges, and the unloading shall be done promptly, even though it may be necessary to place the shell in storage piles. The contractor shall be responsible for all demurrage charges, and when the Commission is required to pay demurrage charges as a result of the failure of the contractor to unload the shell or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the contractor for work performed or materials delivered.

The Contractor shall anticipate his shell requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipments of shell to begin, stating the number of cars or barges he desires to be shipped each day to each delivery point. The Engineer shall have authority to discontinue material shipments on account of unfavorable weather conditions making roads and subgrade unsuitable to haul over, and the Contractor shall be responsible for unloading material enroute and shall be given three (3) days notice when shipments of material are resumed.

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

27.05 Method of Measurement: The shell placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, when delivery of material is made on barges, or in the absence of railroad weights, the shell shall be accurately measured, and for the purpose of payment, one (1) cubic yard of clam shell shall be considered to weigh two-thousand (2000) pounds.

27.06 Overhaul on Surfacing: A "quarter-mile cubic yard" is a cubic yard of material overhauled one-fourth ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

27.07 Basis of Payment: The contract unit price per cubic yard of "Clam Shell Surface Course," shall be payment in full for the necessary shaping of the subgrade and shoulders, or cleaning and reshaping the base-course and shoulders, furnishing materials (unless otherwise provided), hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract price per quarter-mile-cubic yard for "Overhaul of Surfacing Material."

ITEM 28. REEF SHELL SURFACE COURSE

28.01 Description: This surface, or wearing course shall be composed of shell and shall be constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness and cross-sections shown on the plans.

28.02 Material: 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 $\frac{1}{4}$ -inch. The foreign matter content shall not exceed 3% by weight when dry.

28.03 Delivery of Shell: Should the contractor be delayed on account of non-delivery of shell to be furnished by the Commission, he shall not be entitled to claims for damages, but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission to deliver shell as agreed.

When shell is to be shipped in, it will, unless otherwise specified, be furnished by the Commission, f. o. b. car siding, or barge landing, at such points as the Engineer and contractor may agree upon. Unless otherwise provided, the contractor shall unload cars and barges, and the unloading shall be done promptly, even though it may be necessary to place the shell in storage piles. The contractor shall be responsible for all demurrage charges, and when the Commission is required to pay demurrage charges as a result of the failure of the contractor to unload the shell or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the contractor for work performed or materials delivered.

The Contractor shall anticipate his shell requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipment of shell to begin, stating the number of cars or barges he desires to be shipped each day to each delivery point. The Engineer shall have authority to discontinue material shipments on account of unfavorable weather conditions making roads and subgrade unsuitable to haul over and the Contractor shall be responsible for unloading material enroute, and shall be given three (3) days notice when shipments of material are resumed.

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

28.05 Method of Measurement: The shell placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, when delivery of material is made on barges, or in the absence of railroad weights, the volume of shells shall be accurately measured and for the purpose of payment, one cubic yard of reef shell shall be considered to weigh sixteen hundred (1600) pounds.

28.06 Overhaul on Surfacing: A "quarter-mile cubic yard" is a cubic yard of material overhauled one-fourth ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

28.07 Basis of Payment: The contract price per cubic yard of "Reef Shell Surface Course" shall be payment in full for the necessary shaping of the subgrade and shoulders, or cleaning and reshaping the base-course and shoulders, furnishing materials (unless otherwise provided), hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract price per quarter-mile cubic yard for "Overhaul of Surfacing Material".

ITEM 29. LOCAL IRON ORE SURFACE COURSE

29.01 Description: This surface, or wearing course shall consist of local iron ore, so-called, and shall be constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness and cross-sections shown on the plans.

29.02 Material: The local iron ore shall consist of the ferruginous sandy or gravelly material from pits designated by the Engineer. Gravel or hard pieces of ore over two (2) inches in largest 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 (50), and forty (40) to fifty (50) per cent shall be retained on the ten (10) mesh sieve.

29.03 Spreading Material: The local iron ore shall be spread by hand on the prepared subgrade, or completed base course, to such a depth that when compacted it will have the thickness shown on the plans. In order to secure the required thickness for any course, the contractor shall set wooden guide boards accurately to line and grade at the edges of the course. The inside edges of these boards shall be set on line with the edges of the course and 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.

29.04 Blading: The Contractor shall be required to blade the surfacing material as often as may be necessary to fill up ruts, thereby allowing for more uniform compaction. This blading will be done under favorable weather conditions, when the surfacing material contains moisture and shall be done as directed by the Engineer.

29.05 Method of Measurement: Accepted material hauled to the road shall be measured by the cubic yard in the vehicle, as delivered on the road. It may also be measured by the original space occupied in pits.

29.06 Overhaul on Surfacing: A "quarter-mile cubic yard" is a cubic yard of material overhauled one-fourth ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, less one (1) mile.

29.07 Basis of Payment: The contract unit price per cubic yard of "Local Iron Ore Surface Course," shall be payment in full for the necessary shaping of the subgrade and shoulders, or cleaning and reshaping the base course and shoulders, furnishing materials (unless otherwise provided), hauling less than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract price per quarter-mile cubic yard for "Overhaul of Surfacing Material".

ITEM 30. SAND CLAY GRAVEL SURFACE COURSE

30.01 Description: This surface, or wearing course shall be composed of an intimate mixture, either natural or artificial, of sand, clay and gravel, and shall be constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades and cross-sections shown on the plans.

30.02 Materials: The sand clay gravel shall be composed of either a natural or artificially prepared mixture of sand, clay and gravel. Of this mixture fifty (50) per cent shall be gravel retained on the one-quarter ($\frac{1}{4}$) inch sieve. This mixture of surfacing material shall not contain more than five (5) per cent of mica, feldspar and schist, and shall be free from vegetable or other injurious matter.

When tested by means of laboratory sieves and screens the material shall meet the following requirements:

	Per Cent
Passing 1½-inch screen	100
Passing ¼-inch screen	50

The material retained on the ¼-inch screen shall be uniformly graded from the maximum size to ¼-inch.

The material passing the ¼-inch screen shall meet the following requirements:

	Per Cent
Total sand	60 to 80
Sand retained on 60-mesh sieve	45 to 60
Silt	5 to 15
Clay	10 to 25

30.03 Delivery of Material: Should the Contractor be delayed on account of non-delivery of surfacing material to be furnished by the Commission, he shall not be entitled to claims for damages, but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission to deliver the surfacing material as agreed.

When sand clay gravel is to be shipped in, it will, unless otherwise specified, be furnished by the Commission, f. o. b. car sidings, at delivery points indicated on the plans, and at such other points as the Engineer and Contractor may agree upon. Unless otherwise provided, the Contractor shall unload cars promptly, even though it may be necessary to place the material in storage piles. The Contractor shall be responsible for all demurrage charges, and when the Commission is required to pay demurrage charges as a result of the failure of the Contractor to unload the material, or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the Contractor for work performed or materials delivered.

The Contractor shall anticipate his sand clay gravel requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipments of surfacing material to begin, stating the number of railroad cars he desires to be shipped each day to each delivery point. The Engineer shall have authority

to discontinue material shipments on account of unfavorable weather conditions making roads and subgrade unsuitable to haul over, and the Contractor shall be responsible for unloading material enroute and shall be given three (3) days notice when shipments of material are to be resumed.

30.04 Methods of Construction: The sand clay gravel surfacing shall be spread upon the prepared subgrade, or completed base course, in one or more courses, as indicated on the plans or 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, or trucks of a type that will distribute the material evenly over that part of the subgrade to be covered by the load. In order to secure the required thickness for any course, the Contractor shall set wooden guide boards accurately to line and grade at the edges of the course. The inside edges of these boards shall be set on line with the edges of the course and 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 specified above and the shoulders constructed, the guide boards shall be removed. Spreading by machine is expressly prohibited.

The Contractor, as often as directed, shall work and dress the surface by blading or dragging so that the cross-section shall continue uniform and true to line and grade, and until the surface is smooth, hard, free from ruts and undulations and well bonded, to the width shown on the plans, and the work is accepted. The blade machine for this work, shall weigh not less than three thousand (3000) pounds.

30.05 Method of Measurement: The surfacing material, placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, in the absence of railroad weights, the sand clay gravel surfacing material shall be accurately measured at destination, and for the purpose of payment, one (1) cubic yard of sand clay gravel shall be considered to weigh three thousand (3000) pounds.

30.06 Overhaul on Surfacing: A "quarter-mile cubic yard" is a cubic yard of material overhauled one-quarter ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

30.07 Basis of Payment: The contract unit price per cubic yard of "Sand Clay Gravel Surface Course", shall be payment in full for the necessary shaping of the subgrade and shoulders, or clearing and reshaping the base-course and shoulders, furnishing the materials (unless otherwise provided), hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract unit price per quarter-mile cubic yard for "Overhaul of Surfacing Material".

ITEM 31. WASHED AND SAND CLAY GRAVEL SURFACE COURSE

31.01 Description: This surface or wearing course shall be composed of washed gravel and sand clay gravel, constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness, number of component courses, and cross-sections shown on the plans.

31.02 Materials: The washed gravel shall consist of hard, durable particles of stone uniformly graded in size, having a per cent of wear (abrasion test for gravel) of not more than twenty (20) and, when tested by means of laboratory sieves, shall meet the following requirements:

	Per Cent
Passing 1½-inch sieve	95 to 100
Passing ¼-inch sieve	2 to 15

The sand-clay gravel shall consist of hard, durable particles of stone mixed with sand or clay or similar binding material, and, when tested by means of laboratory sieves shall meet the following requirements:

	Per Cent
Passing 1½-inch sieve	95 to 100
Retained on ¼-inch sieve	25 to 75

That portion retained on the ¼-inch sieve shall be known as "coarse aggregate" and of this material twenty-five (25) to seventy-five (75) per cent shall be retained on the ½-inch sieve. That portion of the sand-clay gravel passing the ¼-inch screen shall be known as "Binder" and of this material fifteen (15) to thirty-five (35) per cent shall pass the two hundred (200) mesh sieve. The cementing value of the binder shall be not less than fifty (50).

31.03 Delivery of Material: Should the contractor be delayed on account of non-delivery of gravel to be furnished by the Commission, he shall not be entitled to claims for damages but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission to deliver gravel as agreed.

When materials are furnished by the Commission, these materials will be shipped, unless otherwise provided, f. o. b. car siding at delivery points indicated on the plans and at such other points as the Engineer and contractor may agree upon. The contractor shall unload cars, and the unloading shall be done promptly, even though it may be necessary to place the materials in storage piles. The contractor shall be responsible for all demurrage charges, and when the Commission has to pay demurrage charges as a result of the failure of the contractor to unload the materials or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the contractor for work performed or material delivered.

The contractor shall anticipate his washed and sand-clay gravel requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipments of surfacing material to begin, stating the number of railroad cars he desires to be shipped each day to each delivery point. The Engineer shall have

authority to discontinue material shipments on account of unfavorable weather conditions, making roads or subgrade unsuitable to haul over, and the Contractor shall be responsible for unloading material enroute and shall be given three (3) days notice when shipments of materials are to be resumed.

31.04 Methods of Construction: The washed and sand-clay gravel surfacing shall be spread upon the prepared subgrade, or completed base course, in one (1) or more courses, as indicated on the plans, or as directed by the Engineer to such depth that when compacted it will have the thickness shown on the plans. Except when spreading a course two (2) inches in depth or less, when machine spreading will be permitted, the material shall be spread by hand from dumping boards, dump wagons, or trucks of a type that will distribute the material evenly over that part of the subgrade to be covered by the load. In order to secure the required thickness for any course, the Contractor shall set wooden guide boards accurately to line and grade at the edges of the course. The inside edges of these boards shall be set on line with the edges of the course and 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 specified above and the shoulders constructed, the guide boards shall be removed. Spreading by machine is expressly prohibited, except as above specified.

The Contractor, as often as directed, shall work and dress the surface by blading and dragging so that the cross-section shall continue uniform and true to line and grade, and until the surface is smooth, hard, free from ruts and undulations and well bonded, to the width shown on the plans, and the work is accepted. The blade machine for this work, shall weigh not less than three thousand (3000) pounds.

31.05 Method of Measurement: The surfacing material placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, in the absence of railroad weights, the washed and sand-clay gravel surfacing material shall be accurately measured at destination, and for the purpose of payment, one (1) cubic yard of washed gravel shall be considered to weigh twenty-seven hundred (2700) pounds, and one (1) cubic yard of sand-clay gravel shall be considered to weigh three thousand (3000) pounds.

31.06 Overhaul on Surfacing: A "quarter mile cubic yard" is a cubic yard of material overhauled one-quarter ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

31.07 Basis of Payment: The contract unit price per cubic yard of "Washed and Sand-Clay Gravel Surface Course" shall be payment in full for the necessary shaping of the subgrade and shoulders, or clearing and reshaping the base-course and shoulders, furnishing the materials (unless otherwise provided), hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract unit price per quarter-mile cubic yard for "Overhaul of Surfacing Material".

ITEM 32. WASHED GRAVEL SURFACE COURSE

32.01 Description: This surface or wearing course, shall be composed of gravel and shall be constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness, number of component courses, and cross-sections shown on the plans.

32.02 Material: Washed or screened gravel shall consist of hard, durable particles of stone uniformly graded in size, having a per cent of wear (abrasion test for gravel) of not more than twenty (20) and, when tested by means of laboratory sieves, shall meet the following requirements:

	Per Cent
Passing 1½-inch sieve	95 to 100
Passing ¾-inch sieve	2 to 15

32.03 Delivery of Material: Should the contractor be delayed on account of non-delivery of gravel to be furnished by the Commission, he shall not be entitled to claims for damages, but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission to deliver gravel as agreed.

When materials are furnished by the Commission, these materials will be shipped, unless otherwise provided, f. o. b. car siding at delivery points indicated on the plans, and at such other points as the Engineer and contractor may agree upon. The contractor shall unload cars, and the unloading shall be done promptly, even though it may be necessary to place the materials in storage piles. The contractor shall be responsible for all demurrage charges, and when the Commission has to pay demurrage charges as a result of the failure of the contractor to unload the materials or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the contractor for work performed or material delivered.

The contractor shall anticipate his washed gravel requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipments of surfacing material to begin, stating the number of railroad cars he desires to be shipped each day to each delivery point. The Engineer shall have authority to discontinue material shipments on account of unfavorable weather conditions, making roads or subgrade unsuitable to haul over, and the Contractor shall be responsible for unloading material enroute and shall be given three (3) days notice when shipments of materials are to be resumed.

32.04 Methods of Construction: The washed gravel surfacing shall be spread upon the prepared subgrade, or completed base course, in one (1) or more courses, as indicated on the plans, or as directed by the Engineer to such depth that when compacted it will have the thickness shown on the plans. Except when spreading a course of two (2) inches in depth or less, when machine spreading will be permitted, the material shall be spread by hand from dumping boards, dump wagons, or trucks of a type that will distribute the material evenly over that part of the subgrade to be covered by the load. In order to secure the required thickness for any

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course, the Contractor shall set wooden guide boards accurately to line and grade at the edges of the course. The inside edges of these boards shall be set on line with the edges of the course and 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 specified above and the shoulders constructed, the guide boards shall be removed. Spreading by machine is expressly prohibited, except as above specified.

The Contractor, as often as directed, shall work and dress the surface by blading and dragging so that the cross-sections shall continue uniform and true to line and grade, and until the surface is smooth, hard, free from ruts and undulations and well bonded, to the width shown on the plans, and the work is accepted. The blade machine for this work, shall weigh not less than three thousand (3000) pounds.

32.05 Method of Measurement: The surfacing material placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, in the absence of railroad weights, the washed gravel surfacing material shall be accurately measured at destination, and for the purpose of payment, one (1) cubic yard of washed gravel shall be considered to weigh twenty-seven hundred (2700) pounds.

32.06 Overhaul on Surfacing: A "quarter mile cubic yard" is a cubic yard of material overhauled one-quarter ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

32.07 Basis of Payment: The contract unit price per cubic yard of "Washed Gravel Surface Course" shall be payment in full for the necessary shaping of the subgrade and shoulders, or clearing and reshaping the base-course and shoulders, furnishing the materials (unless otherwise provided), hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract unit price per quarter-mile-cubic yard for "Overhaul of Surfacing Material".

ITEM 33. BROKEN STONE SURFACE COURSE

33.01 Description: This surface or wearing course, shall be composed of Broken Stone and shall be constructed on the prepared subgrade, or completed base course, in accordance with these specifications and in conformity with the lines, grades, compacted thickness, number of component courses, and cross-sections shown on the plans.

33.02 Material: Broken 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 ten (10) and containing not more than five (5) per cent of soft, friable material and not more than five (5) per cent of flat or elongated pieces, and when tested by means of laboratory sieves shall meet the following requirements:

For the coarse stone.

	Per Cent
Passing 2-inch sieve	100
Retained on 1 $\frac{1}{4}$ -inch sieve	40 to 75
Retained on $\frac{3}{4}$ -inch sieve	95 to 100

For the filler or topping.

	Per Cent
Passing 1-inch sieve	100
Passing $\frac{3}{4}$ -inch sieve	95 to 100
Retained on $\frac{1}{4}$ -inch sieve	40 to 80

33.03 Delivery of Material: Should the Contractor be delayed on account of non-delivery of surfacing material to be furnished by the Commission, he shall not be entitled to claims for damages, but he will be given an extension of time for the completion of his contract equal to the delay or delays sustained by him due to the failure of the Commission to deliver the surfacing material as agreed.

When broken stone is to be shipped in, it will, unless otherwise specified, be furnished by the Commission, f. o. b. car siding, at delivery points indicated on the plans, and at such other points as the Engineer and Contractor may agree upon. Unless otherwise provided, the Contractor shall unload cars promptly, even though it may be necessary to place the material in storage piles. The Contractor shall be responsible for all demurrage charges, and when the Commission is required to pay demurrage charges as a result of the failure of the Contractor to unload the material, or to pay such charges, the amount of such demurrage shall be deducted from amounts that may be or may become due the Contractor for work performed or materials delivered.

The Contractor shall anticipate his broken stone requirements, and shall notify the Engineer in writing ten (10) days in advance of the time he wishes shipments of surfacing material to begin, stating the number of railroad cars he desires to be shipped each day to each delivery point. The Engineer shall have authority to discontinue material shipments on account of unfavorable weather conditions making roads and subgrade unsuitable to haul over, and the Contractor shall be responsible for unloading material enroute and shall be given three (3) days notice when shipments of material are to be resumed.

33.04 Methods of Construction: The broken stone surfacing shall be spread upon the prepared subgrade, or completed base course, in one or more courses, as indicated on the plans or 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, or trucks of a type that will distribute the material evenly over that part of the subgrade to be covered by the load. In order to secure the required thickness for any course, the Contractor shall set wooden guide boards accurately to line and grade at the edges of the course. The inside edges of these boards shall be set on line with the edges of the course and 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 specified above and the shoulders constructed, the guide boards shall be removed. Spreading by machine is expressly prohibited.

The Contractor, as often as directed, shall work and dress the surface by blading or dragging so that the cross-section shall continue uniform and true to line and grade, and until the surface is smooth, hard, free from ruts and undulations and well bonded, to the width shown on the plans, and the work is accepted. The blade machine for this work, shall weigh not less than three thousand (3000) pounds.

33.05 Method of Measurement: The surfacing material, placed and accepted shall be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, in the absence of railroad weights the broken stone surfacing material shall be accurately measured at destination, and for the purpose of payment, one (1) cubic yard of broken stone (coarse grading) shall be considered to weigh twenty-six hundred and fifty (2650) pounds, and for the topping (fine grading) twenty-seven hundred and twenty-five (2725) pounds.

33.06 Overhaul on Surfacing: A "quarter-mile cubic yard" is a cubic yard of material overhauled one-quarter ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

33.07 Basis of Payment: The contract unit price per cubic yard of "Broken Stone Surface Course", shall be payment in full for the necessary shaping of the subgrade and shoulders, or clearing and reshaping the base-course and shoulders, furnishing the materials (unless otherwise provided) hauling not more than one (1) mile, laying, spreading, compacting and reshaping the course, and constructing the course complete according to the plans and specifications.

Hauling material beyond the first mile shall be paid for at the contract unit price per quarter-mile-cubic yard for "Overhaul of Surfacing Material".

ITEM 34. OVERHAUL ON LOCAL BINDER

34.01 Description: This item shall consist of the loading, overhauling and spreading of "Local Binder" beyond a free haul limit of one thousand (1000) feet, in accordance with these specifications, and as directed by the Engineer.

34.02 Material: The material to be used as binder will be designated by the Engineer, and shall be considered as clay, sand-clay or top soil, excluding humus, decayed vegetation or other deleterious substances.

34.03 Method of Measurement: A "station yard" is a cubic yard of material overhauled one hundred (100) feet. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one thousand (1000) feet. The quantity of binder so overhauled shall be determined by measurement of the space occupied in vehicles at the point of placement.

34.04 Basis of Payment: This item shall be paid for at the contract unit price for "Station Yard Overhaul of Binder", which price shall be full compensation for all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

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PAMPHLET "G"

LOUISIANA
HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

AUGUST, 1932

Item 36. Plain Portland Cement Concrete Pavement.

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ITEM 36. PLAIN PORTLAND CEMENT CONCRETE PAVEMENT

36.01 Description: This item shall consist of a wearing course composed of Portland Cement Concrete with or without reinforcing steel as required, and shall be constructed in one (1) course on the approved prepared subgrade or completed and accepted base, in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the plans.

36.02 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.

(a) A mixer, smaller than a five (5) sack batch rated capacity, will not be permitted to be used, unless so specified in the special provisions.

MATERIALS

36.03 Tests: Unless otherwise noted all materials shall be sampled and tested in accordance with methods prescribed in the Tentative Standard Methods of Sampling and Testing Highway Materials A. A. S. H. O. insofar as these methods cover such tests.

36.04 Cement: The cement used shall meet the requirements for Portland cement prescribed in the latest Standard Specifications of the American Society of Testing Materials. The cement shall be delivered in sacks containing ninety-four (94) pounds and each sack shall be considered as having a volume of one (1) cubic foot. Cement salvaged from discarded or used sacks will not be permitted to be used. All such salvaged cement shall be the property of the Louisiana Highway Commission and shall be disposed of as the Engineer may direct. When high-early-strength cement is used, the cement shall conform to Tentative Standard Specifications for High-Early-Strength Cement, Specifications M-39 A. A. S. H. O.

36.05 Storage: The Contractor shall provide suitable means for storing and protecting the cement against dampness. Any retrogression in quality occurring during the storage period will be cause for rejection. All cement having been in storage for a period of ninety (90) days or longer shall be retested before allowed for use.

36.06 Damaged Cement: Bags of cement, which for any reason has become partially set, or which contain lumps of caked cement shall be rejected. In no instance will any portion of a bag of damaged cement, or a bag containing lumps of caked cement be used except after having been reconditioned satisfactory to the Engineer and retested.

36.07 Mixing Different Cements: Cement of different brands or from different mills shall not be used in any one class of construction except as approved by the Engineer.

36.08 Transportation of Cement: All cement shall be delivered to the mixer in bags and deposited directly into the skip with the aggregates or directly on the aggregates just prior to the depositing of the batch into the mixer skip. No cement shall be deposited on the aggregates at a greater distance from the mixer than one hundred (100) feet, and at a less distance or directly into the mixer skip as instructed by the inspector, on windy days.

36.09 Weights: Cement varying more than five (5) per cent from designated weights, namely, ninety-four (94) pounds per sack, and three hundred and seventy-six (376) pounds per barrel, will be rejected: (1st) in car load lots if the average of fifty (50) sacks taken at random is less than the designated weights; (2nd) in individual sacks if tests disclose that sacks vary more than five (5) per cent from designated weights and still the average of fifty (50) sacks is within the specified requirements. In the second instance the cement may be used, providing the proper adjustment per sack is made, this adjustment to be made by weight only.

36.10 Water: Water used in mixing Portland Cement Concrete shall be fresh, reasonably clear, free from oil, acid, alkali, organic or vegetable matter. It shall not be brackish, and must be tested and approved prior to use.

Test of water shall be made in accordance with Method of Test for Quality of Water to be Used in Concrete, Tentative Method T-26 A. A. S. H. O.

36.11 Fine Aggregate: 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 colorimetric test for organic impurities and producing a color darker than plate four (4), Tentative Method T-21 A. A. S. H. O. shall be withheld from use pending satisfactory strength test.

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

Passing No. 4 sieve.....	95 - 100 percent
Passing No. 16 sieve.....	65 - 95 percent
Passing No. 50 sieve.....	5 - 30 percent
Passing No. 100 sieve not more than.....	7 percent

Sand from any one source varying more than 0.20 in fineness modulus shall not be considered as being uniform and shall be rejected or stored separately to permit adjustments in the mix if necessary.

(a) **Strength:** Fine aggregate when subjected to the mortar strength test, Tentative Method T-35 A. A. S. H. O., shall show a strength equal to or greater than that developed using the same cement and standard Ottawa sand.

(b) **Local Sand Requirements:** Preliminary test of local sands shall only be considered as an indication of their quality. These tests will be made upon the request of any parties entitled to this consideration and need not be officially taken by representatives of the Louisiana Highway Commission unless requested. In the case the preliminary tests indicate that the sand is of the quality required for fine aggregate in concrete mixtures, it will be necessary to stockpile the material in not less than two hundred (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 stockpile this quantity, the maximum amount possible to stockpile will be accepted as a unit. For stockpiles

larger than two hundred (200) cubic yards one sample shall be taken from approximately every two hundred (200) cubic yards. The material in the stockpile will be sampled officially by representatives of the Louisiana Highway Commission and forwarded to the laboratory for test purposes. If the test results of the official sample from the stockpile indicate that the sand does not meet the requirements, an adjustment of the cement content in the mixture may be allowed within reasonable limits by the addition of the proper amount of cement, as directed by the Testing Laboratory, based upon the test results of the official sample. Check tests will be made when requested in writing by the Contractor, but the use of the material will be governed by the original test until subsequent test results are available.

36.12 Coarse Aggregate: Coarse aggregate shall consist of gravel, crushed stone, slag or a combination of gravel and crushed stone.

(a) All gravel shall consist of clean, tough, durable stone of high resistance to abrasion, free of clay or coatings 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 fifteen (15) per cent of thin and elongated particles and shall have a per cent of wear of not more than twenty (20). 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	6.0

(b) 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 of not more than nine (9). 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.

(c) Broken slag shall consist of clean, tough, durable pieces of air-cooled copper or iron furnace slag, reasonably uniform in density and quality non-glassy and free from thin or laminated pieces or any deleterious substance. It shall contain not more than 1.5 per cent of sulphur and the dry slag when shaken to refusal shall have a weight per cubic foot of not less than seventy-five (75) pounds. The loss by abrasion shall not be more than fifteen (15) per cent.

36.13 Gradation of Coarse Aggregates: 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

Type Mix	2¾	2½	2	1½	1	¾	No. 4
"A" Gravel		100	90-100		40-80		0-5
"B" Gravel			100	85-100		40-85	0-5
"C" Comb.	See grading requirements below						0-5
"D" Slag		100	95-100		40-70	10-30	0-5
"E" Comb.	See grading requirements below						0-5
"F" Stone	100	90-100		40-70		0-25	0-5

Coarse aggregate from any one source having a variation in fineness modulus greater than .15 shall not be considered as being uniform and shall be rejected or stored separately to permit an adjustment in the mix if necessary.

For Type "E" or Type "C" Mix the smaller size or larger size coarse aggregate may consist of either gravel or crushed stone conforming to the quality requirements of paragraph 36.12. 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:

Type "C" Mix	Type "E" Mix	
Passing 2¼	Passing 2½	100 per cent
2¼ 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

Without written permission from the Testing Engineer the individual sizes of coarse aggregate will be restricted as follows: The smaller size coarse aggregate for Type "C" Mix shall not have more than 10 per cent retained on the ¾ inch sieve. The smaller size coarse aggregate for Type "E" Mix shall not have more than 10 per cent retained on the 1 inch sieve. The larger size coarse aggregate for Type "C" Mix shall not have more than 20 per cent passing the ¾ inch sieve. The larger size coarse aggregate for Type "E" Mix shall not have more than 20 per cent passing the 1 inch sieve.

36.14 Mixing Different Materials: Different types of coarse aggregate, 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 State Highway Engineer in writing or in Type "E" and Type "C" Mixes.

The coarse aggregate in Type "E" and Type "C" mixes shall be shipped to the job in two (2) sizes and combined by proportioning separately for each batch. The two (2) sizes of coarse aggregate mentioned will be designated as smaller and larger size coarse aggregate.

36.15 Composition of Concrete:

Type "A" Mix. This pavement shall consist of concrete composed of one (1) part of Portland cement and five and one half (5½) parts of total fine and Type "A" gravel coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate, and three and one half (3½) parts of gravel coarse aggregate, by volume.

Type "B" Mix. This pavement shall consist of concrete composed of one (1) part of Portland cement and five (5) parts of total fine and Type "B" gravel coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate, and three (3) parts of gravel coarse aggregate, by volume.

Type "C" Mix. This pavement shall consist of concrete composed of one (1) part of Portland cement and five and three quarters (5¾) parts of fine, small size and large size Type "C" coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate and three and three quarters (3¾) parts of coarse aggregate by volume.

Type "D" Mix. This pavement shall consist of concrete composed of one (1) part Portland cement and five and one half (5½) parts of total fine and Type "D" broken slag coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate, and three and one half (3½) parts of broken slag coarse aggregate by volume.

Type "E" Mix. This pavement shall consist of concrete composed of one (1) part Portland cement and six and six tenths (6.6) parts of total fine, small size and large size Type "E" coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate, and four and six tenths (4.6) parts of coarse aggregate by volume.

The Contractor's attention is directed to the fact that in Type "E" and Type "C" Mixes, the two coarse aggregates will reduce in volume approximately eight (8) per cent on becoming mixed.

Type "F" Mix. This pavement shall consist of concrete composed of one (1) part Portland cement, and five and one half (5½) parts of total fine and Type "F" crushed stone coarse aggregate by dry rodded volume, measured separately. The mix will be approximately one (1) part cement, two (2) parts fine aggregate and three and one half (3½) parts of coarse aggregate by volume.

The ratio of fine aggregate to coarse aggregate may be varied by the Physical Testing Engineer, but in no case shall it be varied so as to materially effect the unit volume of cement per unit volume of concrete as determined by original proportions.

The Unit Weight of the aggregates in a dry and rodded condition, shall be determined by the Testing Laboratory. The unit weight of aggregates, of a given specific gravity, is controlled by the voids and may effect the yield of concrete materially.

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 Contractor may bid on any or all types of mixes hereinbefore specified, but shall submit a separate unit price on each type of mix on which he bids.

The Contractor's attention is here directed to paragraph 36.23 of these specifications, "Devices for and Methods of Measuring Materials."

The minimum daily cement content in barrels per cubic yard of concrete for the various types of mixes shall not be less than; or 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 Mix	Gallon Per Bag	Barrels Per Cu. Yd.
"A"	5.50	1.35
"B"	5.50	1.45
"C"	5.75	1.30
"D"	5.50	1.50
"E"	6.00	1.25
"F"	5.50	1.50

Attention is directed to the fact that these are the minimum cement contents permitted, but are not assured by the Louisiana Highway Commission since the cement content obtaining for any type mix is dependent upon the gradation of the aggregates

within the limits of the specification for that type gradation. This cement content is based upon the most ideal combination and gradation of both fine and coarse aggregate.

36.16 Poured Filler: For filling poured joints, dummy joints, cracks, the longitudinal center joint and other fractures in the pavement, a bituminous product meeting either of the specifications of 36.17, 36.18 or 36.18-A may be used. Such filler shall be neatly finished, and extreme care shall be taken to prevent promiscuous dropping of the bituminous product upon the pavement. Any holes showing on the surface of the concrete, caused by pieces of sticks or wood blocks, shall be filled with bituminous material passing these specifications.

Prior to construction of shoulders and prior to opening road for traffic all poured joints, dummy joints, the longitudinal joint, where same is opened sufficiently, cracks and other fractures in the pavement, as soon as visible, shall be filled in the manner and with material specified in sections 36.16, 36.17, 36.18, or 36.18-A. These joints, cracks and fractures and any additional ones occurring in the pavement shall be kept filled with the specified filler until the entire project is completed and accepted by the Commission.

36.17 Asphalt Filler: The asphalt shall be homogeneous, free from water and shall not foam when heated to 175°C. (347°F.). 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 CC1₄, not less than 99.0.

36.18 Coal Tar Filler: The tar shall be homogenous, free from water and shall conform to the following requirements:

1. Specific gravity 25°/25° C. (77°/77° F.), 1.220 to 1.280.
2. Melting point 40° C. (104° F.), to 46° C. (115° F.).
3. Total distillate by weight, to 170° C. (338° F.), not more than 0.5%; to 300° C. (572° F.), not more than 15.0%.

Specific gravity of total distillate 25°/25° C. (77°/77° F.), not less than 1.030.

Melting point of residue, not over 75° C. (167° F.).

4. Total bitumen (soluble in carbon disulphide) 75% to 85%.
5. Inorganic matter (ash) not more than 0.5%.

36.18-A Asphalt Mineral Filler: The filler shall meet the following specifications and shall not foam when heated to 175°C. (347°F.).

(a) Asphalt Cement shall meet the following requirements:

1. Flash point not less than 175°C. (347°F.).
2. Penetration at 25°C. (77°F.), 100 g., 5 sec., 60 to 70.
3. Ductility at 25°C. (77°F.) not less than 30.
4. Penetration of residue (after heating) at 25°C. (77°F.), 100 g., 5 sec., as per cent of original penetration not less than 60.
5. Total bitumen soluble in carbon disulphide, not less than 99.5%.

6. Proportion of total bitumen soluble in carbon tetrachloride, not less than 99%.

(b) Filler material shall consist of an approved filler dust, 95% of which shall pass a 200 mesh screen.

The finished product shall be so combined that it shall meet the following specifications by weight proportion. Material shall be of such quality that when applied to cracks by standard practice the asphalt filler will adhere to concrete slab and will not peel or separate and in this specification it is understood that physical requirements are above parity of chemical analysis below.

1. Bitumen soluble in carbon disulphide 40% to 50%.
2. Filler dust 50% to 60% by weight.
3. Penetration at 25°C. (77°F.), 100 g., 5 sec., 55 to 65.
4. Melting point (Ring and Ball) °F. 125 to 135.

36.19 Premoulded 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 joint filler may be impregnated with finely divided particles of non-metallic material provided that they are uniformly distributed throughout the bitumen. In addition the joint filler shall conform to the following requirements:

Absorption, not more than 5.0%.

Distortion, not more than 1 inch.

Brittleness: The filler shall not crack or shatter when subjected to the test for brittleness.

36.20-A Fabric Reinforcement: Fabric reinforcement shall consist of steel wire members securely fastened at all joints, or points of inter-section, and so constructed that the sheet will retain its original shape during necessary handling.

The steel wire shall comply with Tentative Standard Specification for Cold Drawn Steel Wire Fabric for Concrete Reinforcement, Specification M-32, A. A. S. H. O., and shall be of the size and spacing shown on the plans. For methods of construction see paragraph 36.30.

36.20-B Bar Reinforcement: Steel reinforcing bars used in concrete pavements shall be structural, intermediate, hard or rerolled rail steel. The structural and intermediate grades shall be rolled from new billets made by the Bessemer or open hearth processes and conforming to Tentative Standard Specifications for plain steel concrete reinforcing bars Specification M-31 A. A. S. H. O. Hard and rerolled steel shall conform to the Standard Specifications for Rail Steel Concrete Reinforcing Bars A. S. T. M. Serial Designation A 16-14.

The size and spacing of bars shall be as shown on plans. For methods of construction see paragraph 36.30.

36.21 Calcium Chloride: The use of calcium chloride as an admixture for curing concrete pavement will be permitted as directed by the Engineer. When calcium chloride is used, an approved mechanical apparatus shall be provided for preparing, measuring and placing the solution into the mixer drum. The ratio of water to calcium chloride in making the solution shall be as directed by the Engineer and the proportion of calcium chloride used shall be from one and one-half (1½) to two (2)

pounds per sack of cement. The apparatus used for adding calcium chloride solution to the mixer drum shall be first approved by the Engineer before being allowed for use, and shall be so constructed as to comply with the following requirements:

The solution shall be mechanically agitated during preparation.

The solution shall be fed by force or gravity automatically into the measuring tank.

The solution shall be discharged into the mixer drum automatically at the same place and with the mixing water.

The time required to fill the measuring tank shall not be more than thirty (30) seconds.

The measuring tank shall be so constructed as to deliver accurately to each batch the required amount of solution, and shall be equipped with a water glass for the purpose of observing the amount of solution in the measuring tank.

Calcium chloride will be rejected if it fails to pass any of the requirements of these specifications and if it has become caked or sticky in the containers. Within twenty-four (24) hours after the forms are removed, the edges of the slab shall be back-filled with a suitable material for a width of not less than two (2) feet. As soon as finished, the concrete shall be protected by burlap covers kept moist for at least twenty-four (24) hours.

The calcium chloride used shall be granular or flake, preferably flake and shall conform to the following analysis:

Pure anhydrous Calcium Chloride, not less than 73%.

Magnesium Chloride, not more than 0.5%.

Sodium Chloride, not more than 1.0%.

When tested by means of laboratory screens, 100% shall pass through a three-eighths ($\frac{3}{8}$) inch screen.

Calcium chloride will not be acceptable when shipped in bulk or received in a lumpy condition. It should be furnished in moist-proof bags or in air-tight steel drums. Reasonable care should be exercised in handling same. The calcium chloride shall be used as soon as the container is opened as this material must not stand exposed to the air.

36.21-A Silicate of Soda: Silicate of Soda may be used for curing concrete pavement in accordance with paragraph 36.35. The Silicate of Soda shall have a density of between 42.25° and 42.75° Be., at 60° F., and a ratio of one (1) Sodium Oxide (Na_2O) to not less than three point two (3.2) of Silica (SiO_2).

Approximately one (1) pound and not less than nine-tenths (.9) of one (1) pound of Silicate of Soda to comply with the above requirements shall be placed on each square yard of concrete surface.

CONSTRUCTION METHODS

36.22 Storage of Aggregates: If materials are stock piled, such piles shall be built up in layers not to exceed three (3) feet in height and each layer shall be completely in place before beginning on the next. Coning or building up of stock piles by depositing material in one place will not be permitted.

(a) Mixing of stone or gravel in one storage pile, or alternating layers or batches of different aggregates will not be permitted.

(b) The placing of storage piles at intervals of not less than one thousand (1,000) feet at specially prepared places along the road, preferably on private property, will be permitted upon written authority of the State Highway Engineer.

(c) If the materials become mixed with earth or other foreign matter, or become segregated in such a manner as to render it impracticable to obtain a consistent mixture, at any time previous to the time of charging the mixer, such materials will be rejected, and their use not allowed. If, however, the Contractor cleans or remixes or otherwise treats this material so same will be acceptable under these Specifications, this reworked material will be considered the same as new material.

36.23 Devices for and Methods of Measuring Materials: When measuring materials the method and equipment shall comply with the following requirements:

(a) Fine aggregate in all types of construction shall be measured by weight or by volume in a saturated condition.

(b) The type and character of equipment used in either of the methods mentioned in the above paragraph shall be first approved by the Engineer, and in the event that such equipment should appear satisfactory at first and then found not to be so after being tried, its use shall be discontinued.

(c) When Sand is Proportioned in a Saturated Condition all of the water used to saturate the sand shall be retained and put into the mixer drum, or a satisfactory arrangement shall be made whereby all the water not retained by the sand will drain off before the sand is put into the mixer drum. (Attention is here called to the fact that it is possible that a draining process, especially on a short haul, might render the subgrade unfit for laying concrete). The operation of the inundator shall be such that the water will always be above the sand while the inundator is being filled. The time required to fill the inundator shall not be less than thirty (30) seconds, and a small amount of excess water shall run off when the inundator is filled.

A water tight box of the required capacity and approximately the shape of a cube shall be used for checking the inundator.

(d) Coarse aggregate in all types of construction shall be measured by weight.

(e) When Weighing, the Equipment Used Shall Comply With the Following Requirements:

Accuracy of the scales shall be within one per cent (1%) of the dead weights used to check the scales.

All weighing equipment shall be operated from an elevated platform and the position of the operator shall be such that he can conveniently remove material from the weighing hopper.

The weighing hopper shall be provided with a satisfactory opening to permit the removal of over-weight material.

A device satisfactory to the Engineer shall be used in conjunction with the scale beam to indicate and register at least the last one hundred (100) pounds weight. The final reading shall only be taken when the scale beam is level.

The weighing hopper shall be equipped with a means of adjusting the volume of the compartment in which the aggregate is weighed.

All control levers shall be so arranged as to enable the operator to be within easy access to all levers, and the weighing beam or dial shall be in full view of the

operator when he is in a position to operate the gate which delivers material to the weighing hopper.

Suitable arrangements shall be provided to hold all poises securely in position after being set.

The Contractor shall be required to provide ample protection of the weighing batches against the action of wind.

(f) Allowance will be made for the weight of moisture in the fine and coarse aggregates and shall be set at the average content of the stockpile or cars as determined by the Engineer.

Proper protection of materials as they are being transported from the proportioning plant to the mixer shall be furnished by the Contractor.

All water measuring devices shall be accurate to one-fourth ($\frac{1}{4}$) gallons per bag of cement.

Located on the mixer shall be an open auxiliary water tank so located that water will flow by gravity from such tank direct into the water measuring tank. Water from the supply line shall first be fed into the auxiliary tank and shall then be fed by gravity into the measuring tank without the aid of line pressures. The contractor shall secure the approval of such device by the Engineer before the operation of the mixer is started.

The contractor shall at all times pay particular attention to the water measuring device, it shall at all times be kept in satisfactory working condition. If at any time the water measuring device proves not to be working properly the Engineer shall stop the placing of concrete until satisfactory repairs are made. The Engineer's decision shall be final as to when the water measuring device is not working properly.

Once the water content has been determined the water measuring device shall be set and shall not be changed without authority of the Inspector.

36.24 Handling Materials: Aggregates shall be handled from a central proportioning plant, and be transported in batch-boxes, or vehicle bodies of sufficient capacity to properly carry the entire volume required per batch and be delivered to the mixer in such a manner as to insure that a uniform amount of each class of aggregate is obtained in each batch of concrete.

Truck bodies that leak or drop materials will not be used. The Engineers decision shall be final as to when a truck body needs repairs, and when requested, its use shall be discontinued at once.

The contractor shall not fill the proportioning bins alternately from the stockpile and cars, except when directed to do so by the Engineer for the purpose of changing the gradation of the material, but shall fill the bins exclusively from the stockpile or the cars until the supply has been exhausted or the exhausted supply has been replenished, in other words, the contractor shall avoid as much as possible the mixing of material from the stockpile with material from the cars when filling the proportioning bin.

36.25 Forms: Outside forms for this work shall be of metal, not less than ten (10) feet in length except on curves, of the depth of the concrete, with no horizontal joints, and shall be straight, free from warp, and of sufficient strength, when staked, to resist the pressure of the concrete and finishing machine or finishing tools without

spring or settlement. The Engineer may require the Contractor to operate finishing machine and subgrader over forms prior to the starting of construction that they may be inspected and to determine whether the same will remain true to line and grade during the construction of any portion of the project. Any weakness or defects which may develop in the forms under this operation will be the cause for their immediate rejection. The width of the forms at their base shall be not less than six (6) inches for forms under eight (8) inches in height and not less than eight (8) inches for forms of eight (8) inches in height and over. Only approved steel forms shall be used, weighing not less than eight (8) pounds per linear foot for six (6) inch forms, not less than nine (9) pounds per linear foot for seven (7) inch forms, not less than twelve (12) pounds per linear foot for eight (8) inch forms and not less than thirteen (13) pounds per linear foot for nine (9) inch forms. All roadway forms shall be of metal with a minimum thickness of three-sixteenths ($\frac{3}{16}$) inch. The use of wood or steel blocks to secure the required depth of section shall not be permitted. Forms that become bent or deformed shall be condemned and immediately removed from the work until satisfactorily repaired and straightened. The maximum deviation from a straight line along top surface of form for ten (10) foot section shall be one-eighth ($\frac{1}{8}$) of an inch. These forms shall be inspected and accepted by the Engineer before being returned to the work. Whenever the subgrade is incapable of bearing the weight of the forms, finishing machine or finishing tools without settlement, the Engineer may require suitable stakes driven to the grade of the bottom of the forms, sufficient in number to give the necessary support. The alignment and grade of all forms shall be approved before and immediately prior to the placing of concrete against them. The entire length of the form shall be set directly in contact with the finished subgrade which shall be compacted by rolling for at least twelve (12) inches on each side of roadway outside the area required for the road surfacing. The building of pedestals of earth or other material upon which to rest the forms in order to bring them up to the required grade will not be permitted. For curves of radius less than one-hundred-fifty (150) feet, wooden side forms two (2) inches in width and of the depth of the concrete, of well seasoned dressed planks may be used with written authority of the Engineer. The length of the pins shall not be less than three (3) times the height of the forms, and the number and length of pins shall be increased, if necessary, to maintain the forms to correct line and grade, but in no case shall less than three (3) pins be used to each ten (10) foot section.

Sufficient forms shall be provided, so that it will not be necessary to remove them in less than twelve (12) hours after concrete has been placed, or longer if required.

Forms shall be cleaned before being set to line and grade and oiled before concrete is placed.

At all times sufficient forms shall be used and set so that at least three hundred (300) feet of forms on each side of the roadway shall be accurately set and maintained true to line and grade on a prepared and acceptable subgrade in advance of the point where concrete is being placed.

36.26 Consistency: Only sufficient water shall be used to produce a plastic, workable concrete, of which each and every batch must be of uniform consistency. A plastic and workable concrete is of that consistency in which there is not an in-

herent tendency to flow readily or for the mortar to flow from between the aggregates causing segregation, nor is it of a mealy and harsh consistency which is likely to cause honey combing at the bottom of the slab even though it would finish satisfactorily. The mix should be such that when dropped directly on the subgrade from the discharge bucket the mass will sink slightly in the center and stand up well on the edges. The consistency of the concrete shall be determined by the Engineer.

36.27 Mixing Conditions: The concrete shall be mixed only in the quantity required for immediate use. Concrete that has been mixed longer than thirty (30) minutes or has developed an initial set shall not be used. Retempering concrete by adding water or by other means shall not be permitted.

Concrete may be placed when the air temperature in the shade is 35° F. and rising; concrete shall not be placed when the air temperature in the shade is 40° F. and falling.

The use of admixtures for the purpose of increasing the workability of the mix will be permitted only when specifically approved by the State Highway Engineer in writing.

The use of a Central Mixing Plant will not be permitted except in special instances and after the approval by the State Highway Engineer in writing. Prior to the use of a Central Mixing Plant the Contractor shall submit in detail to the State Highway Engineer methods to be used in transporting and placing concrete. The methods to be used shall be such that:

(a) The hauling causes no segregation of the materials.

(b) The period of time elapsing from the time of mixing to the time of finishing the concrete shall not be longer than the time required for the cement to reach its Initial Set under the prevailing temperature at the job. This time shall be determined in the Laboratory by actual test.

(c) The vehicles transporting the mixed concrete shall be of such capacity, or the batches shall be so proportioned that the mixer can discharge the entire contents of the drum to each vehicle load.

36.28 Mixing Concrete: The materials shall be mixed in a batch mixer of approved type for one (1) minute after all the materials, including all the water, are in the drum, at a speed of not less than fourteen (14) nor more than twenty (20) revolutions per minute. Any batch mixed less than one (1) minute or any batch which by any fault of the Contractor is not satisfactory to the Engineer shall not be allowed in the roadway and shall be disposed of as directed. The mixer shall at all times be kept in good repair to the satisfaction of the Engineer. It shall be equipped with a water measuring device and an approved batch meter having a discharge locking device. The batch meter shall be checked by the Engineer at least once every twenty-four (24) hours.

No materials shall be placed in the drum until all of the previous batch has been discharged. Water shall be added at the time the materials are being run into the mixer.

No single concrete batch shall contain more total materials than that required to yield in finished concrete a volume in excess of twenty-five (25) per cent greater than the manufacturer's rated capacity of the mixer.

36.29 Longitudinal Center Joint: When required by the plans, the pavement shall be constructed with a longitudinal joint in the center of the pavement. This joint shall be formed by means of a metal strip of the gauge and form shown on the plans, and may be either plain, painted or galvanized as shown on the plans. The metal strips shall be not less than ten (10) feet and not more than fifteen (15) feet in length made of one single strip of metal, and shall be held rigidly in place by suitable pins at least eighteen (18) inches long, driven vertically through punched holes in the joint. Except at dummy joints where a gap of three (3) inches must be provided adjoining strips shall be lapped not less than two (2) inches and securely fastened by means of the pins driven through matched holes in the splice, or butt joints may be constructed if suitable clips, approved by the Engineer, are used. The spacing of the holes and the pins shall in no case be greater than shown on the plans. Punched or cut holes shall be provided in the metal strip, spaced as shown on the plans, to receive the transverse bars across the center joint. These bars shall be of length, size, and installed, as shown on the plans. A templet, approved by the Engineer, shall be used to place the joint in horizontal and vertical alignment before depositing and finishing the concrete and care must be used to prevent displacement of the joint material during the operations of placing and finishing.

36.30 Fabric and Bar Reinforcement: Steel reinforcement shall be used only at special locations over questionable subgrade conditions, as shown on the plans or as directed by the Engineer.

Fabric and bar reinforcement shall meet the requirements of paragraph 36.20-A and 36.20-B of these Specifications.

Fabric or bar reinforcement shall be placed at right angles to the center line of the pavement the distance indicated on the plans below and parallel with the surface. The separate sheets shall be lapped as shown on the plans, except at dummy joints where the reinforcement shall be cut when so directed by the Engineer.

All reinforcement shall be free from excess rust, scale, paint or coating of any character which will tend to prevent its bond with the concrete. The reinforcing materials shall be protected from rusting by placing them on a platform under cover, except a sufficient supply for one (1) week's use.

36.31 Placing Concrete: (a) Subgrade: The subgrade shall be properly shaped, rolled and uniformly and firmly 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 (4) to ten (10) tons, or a power-driven roller weighing not less than one hundred seventy (170) pounds per inch width of tread. Any portion inaccessible to the roller shall be compacted thoroughly with hand tampers weighing not less than fifty (50) pounds, the bearing or tamping face of which shall not exceed one hundred (100) square inches in area. All unsuitable soft and yielding material which will not compact readily shall be removed and back-filled with suitable material and the subgrade shall again be rolled until no depressions develop. Under no conditions will material for back-fill be taken from embankments to a greater depth than sub-grade elevations or from holes dug in the back slopes. This excavating and back-filling to be paid for at unit price bid per cubic yard for common excavation. Should sufficient time elapse between the rough grading and the laying

of the pavement to allow the earth to become baked and hardened, whether traffic has been allowed on the subgrade or not, the surface shall be rescarified and re-rolled. No hard surface pavement shall be laid on a frozen subgrade. Frost crystals or mud caused by freezing and thawing shall be removed before placing any roadway material on the subgrade, and shall be replaced with suitable material.

The subgrade must be in a condition so that it will drain readily. In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade, 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.

The subgrade shall be in final condition for receiving roadway materials for a distance of at least five hundred (500) feet in advance of the placing of the roadway materials, forms, etc. No roadway materials, forms, etc., shall be placed until the subgrade has been approved. No materials shall be allowed on the subgrade.

If the roadway of the present road is of gravel or macadam and conforms approximately to the grade of the proposed roadway, then the gravel or macadam road shall be scarified to a depth of six (6) inches unless otherwise directed by the Engineer, and to the width of the proposed surfacing and shaped to conform to the proposed section uniformly compacted.

If the roadway of the present road follows the traveled way of an old road or a furrowed field, then the surface which is beneath the new surfacing shall be thoroughly plowed and scarified to a depth of six (6) inches below the original surface, unless otherwise directed by the Engineer, after which it shall be reshaped and rolled as hereinbefore specified. This is to secure a subgrade of uniform rigidity.

The subgrade will be considered as that portion of the highway on which the surfacing rests. The subgrade shall be interpreted to mean the area lying between points one (1) foot outside that portion on which the surfacing rests. No payment for excavation will be allowed for this additional width.

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.

The subgrade shall be free from boulders, loose stones, muck, quicksand, and all vegetable matter, or other material that in the opinion of the Engineer would prove detrimental to the road. All large, loose rocks or boulders extending close to the surface of the subgrade shall be broken off twelve (12) inches below the surface of the subgrade and removed.

The subgrade and the roadway shall be superelevated and widened on curves as directed by the Engineer in accordance with the standard plans.

(b) Checking Subgrade. Attached to the mixer where conditions allow shall be a drag template as shown on the Sheet of Standards, for the purpose of bringing the subgrade true to grade and section. Immediately before placing the concrete, the subgrade between the mixer and concrete shall be checked with an approved template, as shown on the Sheet of Standards, and in no case shall this board be dragged or used for the purpose of bringing the subgrade true to grade. If loose earth to the depth of over $\frac{1}{2}$ inch is thrown in to bring the surface to grade, it should be thoroughly tamped with an acceptable hand tamp.

(c) Placing Concrete. Concrete shall be placed only on a moist subgrade. If the subgrade is dry it shall be sprinkled with as much water as will be absorbed readily. When it is found necessary the subgrade shall be sprinkled ahead of the mixer. The subgrade shall be uniform in its bearing capacity. Where the pavement is to be laid adjacent to railway tracks or around structures, no concrete shall be placed until the tracks and structures have been set to the required grade and alignment in advance, and all structures which project through the pavement shall be cleaned thoroughly and painted with asphalt or tar to prevent adhesion of the concrete. No concrete shall be poured on a frozen subgrade.

The mixer is to be located where the pavement is to be laid unless otherwise permitted in writing by the Engineer. The concrete shall be deposited on the subgrade rapidly, in successive batches, by means of a discharging device approved by the Engineer, which does not cause separation of the matrix and the coarse aggregate, and shall be distributed to the required depth for the entire width of the pavement by shovel cutting and tamping or other approved methods, and the sides well spaded. Rakes or hoes shall not be used for handling concrete. Sections less than ten (10) feet in length shall be removed if so directed by the Engineer.

At no time shall more concrete be laid than can be immediately and properly finished and properly covered during daylight, unless an adequate lighting system, of illuminating gas, acetylene gas, or electric lights, satisfactory to the Engineer, are provided.

36.32 Constructing Transverse Joints: Transverse joints shall be formed at right angles to the center line at the end of each day's work to the full depth and width of the pavement. They shall be plain butt joints. All joints shall be formed during the placing of the concrete by securely staking an approved bulkhead, as shown on the plans, at right angles to center line and perpendicular to and flush with the surface of the pavement. In addition, the joint shall consist of three-quarters ($\frac{3}{4}$) inch round, smooth steel bars four (4) feet long, dipped in or painted with heavy oil, their entire length, to insure freedom of movement within the concrete. These bars shall be straight and placed midway between crown and bottom of pavement, before concrete is placed at joint, so that they will extend one-half of their length into the finished work, and shall be held in place by the bulkhead and bar rest, and shall not be burred at their ends. Transverse joints shall also be formed whenever the placing of concrete is stopped. The manner and method of placing these joints shall be as specified above except that in lieu of using the standard header board for use at the end of a day's run, the joint shall be formed by placing a header one and one-fourth ($1\frac{1}{4}$) inches wide and conforming to the crown of the subgrade and the finished pavement as shown on the plans. After the concrete has sufficiently hardened, this header will be pulled, and the joint filled as specified under Paragraph 36.16 of these specifications. Details of these joints are shown on Typical Section. In finishing these joints they shall be finished with an edging tool of one-eighth ($\frac{1}{8}$) inch radius and checked with an approved straight edge to insure an even surface.

An expansion joint one and one-quarter ($1\frac{1}{4}$) inches wide filled with a filler meeting the requirements of paragraphs 36.17, 36.18, or 36.18-A shall be constructed at each end of all structures where the pavement abuts same, and a second joint shall be placed at a point approximately fifty (50) feet back from each end of the structure.

These joints shall be constructed at right angles to the center line of the roadway and as directed by the Engineer.

Dummy joints spaced forty (40) to sixty (60) feet, as directed by the Engineer, shall be constructed in the slab at right angles to the center line. These joints shall be approximately two (2) inches deep and one-quarter ($\frac{1}{4}$) inch wide and edged; tools and workmanship to meet the approval of the Engineer. All labor, materials, tools, etc., required to construct these joints shall be included in the price bid per square yard of pavement.

The roadway slab is to flare out to the width of roadway between curbs at each end of structure, and at a distance from the abutment as required for different width bridges, and as directed by the Engineer. This extra width will be paid for at the contract unit price per square yard of pavement.

It is thoroughly understood by the Contractor that the cost of placing these expansion joints on each side of structures is to be included in the price bid per square yard for pavement.

36.33 Consolidating and Finishing: Mechanical methods of consolidating and finishing shall be employed to strike-off and compact the concrete, except where the width of the pavement changes on curves or at other points on special sections and in cases of breakdowns or other emergencies, hand methods of finishing will be permitted.

(a) **Machine Finishing:** When the concrete is to be machine finished, it shall be spread by hand to a fairly uniform surface which is from one (1) to two (2) inches above the grade of the finished surface. It shall be struck off with the finishing machine, so that after shaping as herein specified, the pavement surface will not be compressed below the established grade.

No mechanically operated tamping device will be permitted, except by written permission of the State Highway Engineer.

At least three men shall be kept in front of the finishing machine to keep sufficient material ahead of strike-board and excess material from accumulating and being pushed ahead by the strike-board or shaping device. The strike-board or shaping device shall be checked at intervals in order to secure the required grade, crown and finish. The finishing machine shall screed or shape the concrete at least two times and more if deemed necessary by the Engineer, but after the first strike-off there shall be no walking in the concrete ahead of successive strike-offs.

The maximum weight of Finishing Machines shall not exceed 6,000 pounds except with written permission from the State Highway Engineer.

No finishing machine shall be used unless operated by an experienced operator. The Contractor shall furnish a statement to the Engineer giving the previous experience of the operator. At no time shall inexperienced men be allowed to operate the finishing machine until sufficient instruction, as adjudged by the Engineer, has been given by an experienced operator.

All concrete or other material must be kept off the top of the side forms, and the shaping or consolidating device must be kept perpendicular to the axis of the pavement.

(b) **Finishing Tools:** After the concrete has been struck off it is required that the following named finishing tools, as shown on Standard Tool Sheets, be used as directed by the Engineer.

Longitudinal Float, Transverse Float, Straight Edge Float, Bow Belt, Long Handle Float, Hand Float and Edging Tools. The Standard Tool Sheets also show details of check boards, bridges, etc., all of which are required as shown. All tools, check boards, etc., which have, in the opinion of the Engineer, become unsatisfactory for use, must be immediately replaced by new ones.

Mechanically operated belts may be substituted for bow belt when approved in writing by Engineer.

The outer edge of the concrete pavement shall be finished with an approved edging tool of three-quarters ($\frac{3}{4}$) inch radius, as shown on Sheet of Standards.

(c) **Correction of Defective Surface:** As soon as the concrete has set sufficiently to permit walking on it without marring the surface, it shall be straightedged along the center and both quarters using a straightedge ten (10) feet in length as shown on Sheet of Standards, and all variations exceeding one-eighth ($\frac{1}{8}$) inch shall be plainly marked. The Contractor shall immediately thereafter correct such variations, by rubbing down high spots and refinishing. If necessary that rubbing be continued after contact with the course aggregate is made, in no case, shall it be done in such manner or carried to such extremes that the bond of the concrete will be broken.

36.34 Protection of Concrete: As soon as finished the concrete shall be protected by burlap covers as directed by the Engineer. There shall be on the job at all times sufficient burlap to cover a days run of concrete. The burlap shall be in first class condition, free from all holes, dirt, clay and foreign matter, and of sufficient length to satisfactorily cover the entire width and sides of pavement. The burlap shall be thoroughly wet before being placed on the green concrete. The covering shall at once be sprinkled with water and kept wet until removed. Under no conditions will the burlap covering be removed in less than twenty-four (24) hours. When the concrete has hardened sufficiently, and in not less than twelve (12) hours nor more than thirty-six (36) hours, except during extremely hot weather, when at the option of the Engineer this time may be decreased, the forms shall be removed, honeycombs pointed up, and the sides of the pavement for a width of two (2) feet from the edges shall be backfilled with a suitable material, and the method of curing elected by the Contractor as hereinafter specified in paragraph 36.35 shall be followed.

Traffic shall be excluded from the concrete for a period of fourteen (14) days by the erection and maintenance by the Contractor of suitable barricades. These barricades shall be adequate to completely exclude traffic, and satisfactory and competent night and day, or both, watchmen shall be furnished when required by the Engineer.

When bridges or ramps are required by property holders for egress and ingress across the pavement, 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 bridge shall be constructed of timbers to entirely bridge 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 (12) inches of earth on the pavement and covering same with two (2) inch planks placed parallel to the center line of the highway. However, no earth ramp shall be constructed until the pavement is at least forty-eight (48) hours old, and then only in a manner as specified above.

36.35 Curing Concrete: The finished concrete may be cured by covering the pavement with earth and maintaining as hereinafter provided, or by ponding, or by Calcium Chloride as an admixture, during the calendar months of December, January, February, and March, or by a surface application of Silicate of Soda. The Contractor shall be required to stipulate the method he desires to use, in writing, in advance of the beginning of paving operations.

(a) **Earth Curing:** After the removal of the burlap, and the completion of the operation outlined in Paragraph 36.34, the entire surface, including sides of the pavement and to a width of twelve (12) inches outside the edges, shall be wetted thoroughly and covered with earth to a depth of not less than two (2) inches. This material shall be kept soaked with water for ten (10) consecutive days, and shall remain on the concrete for a period of not less than fourteen (14) days.

For each one thousand (1000) feet of concrete pavement which has been laid less than ten (10) days, there shall be at least one man provided with at least one hundred (100) feet of hose who shall devote his entire time to watering the concrete pavement and its earth covering. The water supply pipe line shall be provided with taps and hose connections not more than two hundred (200) feet apart and at least twenty (20) pounds per square inch pressure shall be applied to each tap.

After the foregoing period of fourteen (14) days has elapsed, the covering of the concrete shall be removed, and the surface of the pavement thoroughly cleaned and opened to traffic. In no case shall traffic be permitted to use concrete pavement until it has been cleaned, and is free from the earth covering.

(b) **Ponding:** The method of curing known as ponding may be used if desired and permitted, the entire surface of the concrete being maintained inundated with at least two (2) inches of water for ten (10) consecutive days, but shall not be opened to traffic in less than fourteen (14) days, and then only after the earth dykes have been removed.

(c) **Calcium Chloride:** During the calendar months of December, January, February and March when elected by the Contractor, the curing of concrete pavement by an admixture of Calcium Chloride will be permitted when it meets all of the requirements of paragraph 36.21. After the burlap covering has been removed and the edges of the pavement backfilled, no further curing will be necessary, but traffic shall be excluded for a period of fourteen (14) days.

If at any time in the opinion of the Engineer, the apparatus used to add the Calcium Chloride solution to the mix is not working properly, the Contractor shall discontinue the use of Calcium Chloride and use Wet Earth or Ponding for curing until satisfactory repairs can be made.

If at any time in the opinion of the State Construction Engineer the use of Calcium Chloride makes it difficult to obtain the best construction the Contractor may be required to discontinue the use of Calcium Chloride and use Wet Earth, Ponding or Silicate of Soda for curing.

(d) **Silicate of Soda:** The concrete pavement shall be cured in the usual way by covering the surface with burlap as soon as possible after finishing without marring the surface and kept thoroughly wet for not less than twenty-four (24) hours. The burlap may then be removed and the surface of the pavement entirely covered with Silicate of Soda with amount specified in paragraph 36.21-A. The Silicate of Soda in this instance shall be diluted with water to density of between 36° and 37° Be., at

60°F., which will make the mixture of approximately one (1) part water mixed with three (3) parts of Silicate of Soda. This mixture shall be thoroughly stirred before use to make a uniform solution.

The Silicate of Soda solution shall be brushed with a broom having pliable fibers, or sprayed uniformly over the surface. It shall not be applied during a rain, or if any surface water is present on the concrete. If rain occurs within six (6) hours after such application, the concrete shall be recoated with a solution consisting of one (1) part Silicate of Soda and one (1) part of water by volume.

The twenty-four (24) hours of wet burlap is to be literally complied with, in other words, pavement poured the last thing at night is not to be uncovered by removal of the burlap until the following day just before night.

To insure that the proper amount of Silicate of Soda is applied the Inspector shall note the number of pounds of Silicate in the drum (stamped thereon) and shall lay off the correct lineal feet of pavement so that the square yards will equal the number of pounds in the drum. The Silicate of Soda may then be diluted as per above and at least the entire drum is to be placed on the section laid off.

The Inspector shall examine the surface after application of the Silicate and if any areas have been left uncovered he shall require that additional Silicate of Soda be applied to the spots.

The Inspector shall at all times be equipped with a hydrometer and the density of each batch of the solution, after being made according to paragraph three (3), shall be taken by the Inspector and adjustments in the proportion of water and Silicate of Soda shall be made if necessary by the Inspector so that the density of the solution, after being thoroughly stirred, shall be between 36° and 37° Baume.

After the foregoing application of Silicate of Soda the pavement shall be kept closed to traffic the specified fourteen (14) days.

36.36 Cold Weather Curing: During cold weather, when the air temperature may be expected to drop below forty (40) degrees F., a sufficient supply of straw, or other material suitable for covering shall be provided along the line of work and any time the air temperature may reasonably be expected to reach the freezing point during the day or night, the material specified herein shall be spread over the surface of the concrete to a sufficient depth to prevent freezing until the concrete has been deposited for at least five days. It is understood that the Contractor is responsible for the quality and strength of the concrete laid under all weather conditions and concrete which may have become damaged by frost shall be replaced at the Contractor's expense upon written notice from the State Highway Engineer.

36.37 Field Laboratory: The Contractor shall provide a field laboratory in which to house and use the testing equipment, said laboratory to be not less than ten (10) feet wide, twelve (12) feet long and seven (7) feet high, floored, containing not less than two (2) windows and a workbench with necessary drawers; this laboratory is to be used exclusively for testing purposes by the Engineer or his Inspector.

36.38 Method of Measurement: This pavement shall be measured by the square yard along the surface of the pavement, complete in place.

36.39 Basis of Payment: All completed and accepted pavement will be paid for at the contract unit price per square yard for "Plain Portland Cement Concrete Pavement", complete in place, which price shall be full compensation for all dowel

bars, tie rods, and for the furnishing of all the material unless otherwise specified, all forms, equipment, tools, labor and incidentals necessary to complete the pavement in compliance with the plans and specifications.

Fabric or bar reinforcement will be paid for at the contract unit price bid per pound, complete in place, under Items 36.20-A or 36.20-B, which price shall include all materials, equipment, tools, labor and work incidental to complying with the plans and specifications.

Poured filler will be paid for at the contract unit price bid per ton, complete in place, under Items 36.17, 36.18 or 36.18-A, which price shall include all materials, equipment, tools, labor and work incidental to comply with the specifications, invoice weights to govern.

Payment will be made under

- Item 36-A, Type "A" Mix, (per square yard)
- Item 36-B, Type "B" Mix, (per square yard)
- Item 36-C, Type "C" Mix, (per square yard)
- Item 36-D, Type "D" Mix, (per square yard)
- Item 36-E, Type "E" Mix, (per square yard)
- Item 36-F, Type "F" Mix, (per square yard)
- Item 36.17, Asphalt Filler, (per ton)
- Item 36.18, Coal Tar Filler, (per ton)
- Item 36.18-A, Asphalt Mineral Filler, (per ton)
- Item 36.20-A, Fabric Reinforcement, (per pound)
- Item 36.20-B, Bar Reinforcement, (per pound)

LOUISIANA HIGHWAY COMMISSION

PAMPHLET "K"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

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- Item 49. Concrete Pipe.
 - Item 50. Corrugated Galvanized Metal Pipe.
 - Item 51. Relaying Culvert Pipe.
 - Item 52. Cast Iron Pipe.
 - Item 53. Vitrified Clay Pipe.

ITEM 49. CONCRETE PIPE

49.01 Description: This item shall consist of furnishing concrete pipe, conforming to these specifications and of the sizes and dimensions required, and installing such pipe at such places as are designated on the plans, or by the Engineer, and in conformity with the lines and grades given.

49.02 Concrete Pipe: This pipe shall be manufactured of a mixture of Portland cement, sand and coarse aggregate and, in diameters over fifteen (15) inches, shall be reinforced with woven wire mesh, rods, hoops or spirals. The design, materials and manufacture, shall produce pipe conforming to these specifications.

Portland cement shall conform to the requirements of the standard specifications and tests of the American Society for Testing Materials, Serial Designation C 9-26.

The 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 deleterious substances.

The coarse aggregate shall be composed of sound particles of gravel or broken stone.

The reinforcement shall meet the requirements of the standard specifications of the American Society for Testing Materials for cold-drawn steel wire for concrete reinforcement, Serial Designation A 82-27 or for billet-steel concrete reinforcement bars, Serial Designation A 15-14, structural or intermediate grade.

The pipe shall be of the bell and spigot, tongue and groove, or other type which has been approved by the Engineer. The pipe shall be manufactured in sections not less than 2½ nor more than 8 feet in length. The shell thickness and the area of the circular reinforcement shall meet the following requirements:

Inside Diameter of Pipe in Inches	Minimum Thickness of Shell in Inches	Minimum Area of Circular Reinforce- ment in Square Inches per Linear Foot of Pipe
12	1	None
15	1¼	None
18	2	1 Line .101
24	2½	1 Line .101
30	3	1 Line .140
36	3½	1 Line .241
42	4	2 Lines .290
48	4½	2 Lines .290

The spacing of the circular reinforcement shall not exceed 4 inches, center to center.

Single lines of reinforcement shall be placed at equal distances from the inside and outside surfaces of the pipe. Double lines of reinforcement shall be placed parallel to each other and not less than three-fourths (¾) of an inch from the inside and outside surface walls of the pipe.

The reinforcement shall be welded, or if not welded it shall be lapped not less than thirty (30) diameters. Each line of circular reinforcement shall have sufficient longitudinal bars or members extending through the barrel of the pipe to afford rigidity and maintain the reinforcement in exact shape and in the correct position within the form.

Each section of concrete pipe shall be straight and of true circular form. It shall have a uniform thickness of shell and shall be free from porous and scaly spots, and spalled edges. Sections having defective areas, or spots patched or plastered over, will be rejected. The pipe shall be constructed in such manner, and of such design that the joints will meet the same requirements for strength as stipulated, in these specifications, for the pipe.

The pipe shall be properly cured and will be tested only after it has been allowed to age not less than fourteen (14) days.

The pipe shall not have an absorption greater than eight (8) per cent.

Each length of pipe shall be clearly marked with the manufacturer's name, initials or trade-mark, and the date of manufacture.

When tested by the three-edge bearing method of testing for crushing strength all pipe shall withstand an ultimate load in pounds per linear foot of pipe of 1500 D, where "D" is the inside diameter of the pipe in feet. All reinforced pipe shall show no crack under a load in pounds per linear foot of pipe of 1000 D.

Each manufacturer of concrete pipe will be required to provide a suitable and accurate testing machine for testing the pipe at the factory. This machine must be kept in satisfactory condition at all times, and the Engineer shall be furnished with every necessary facility and assistance for performing the tests. Tests will be made when deemed advisable by the Engineer.

49.03 Materials for Mortar Joints: The Portland cement for mortar joints shall conform to the requirements of the standard specifications and tests of the American Society for Testing Materials, Serial Designation C 9-26.

The sand for mortar joints 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 deleterious substances. It shall be approved by the Engineer prior to use.

49.04 Methods of Testing: Tests of the materials and of the pipe shall be made in accordance with the latest methods adopted by the American Association of State Highway Officials.

49.05 Source: The Contractor shall notify the State Highway Engineer of the source from which he intends to procure the concrete pipe for use on the project so that investigation may be made in advance by the Testing Engineer to ascertain whether or not the pipe from that particular source meets the requirements of the specifications.

49.06 Installation: Concrete pipe shall be laid, true to line and grade, on a bed which is uniformly firm throughout its entire length. Where the pipe is to be laid below the natural ground line, a trench shall be excavated to the required depth, and the bottom of the trench shall be shaped to conform to the bottom of the pipe, so as to afford a uniformly firm bed throughout its entire length. Where the pipe is not laid in a trench, a uniformly firm bed shall be made for the bottom of the pipe. When a pipe of the bell, or hub, and spigot type is used, cross trenches, just sufficient to admit the bell, or hub, of the pipe shall be cut across the bed, thereby allowing the body of the pipe to rest upon the prepared bed.

If, in the opinion of the Engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and

backfilled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least four (4) inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material for the entire length of the culvert.

The pipe shall be laid beginning at the lower end with the hubs, or receiving end, up-grade. The spigot, or tongue end shall be inserted into the hub, or receiving end, as far as the construction of the pipe will permit.

The lower portion of the bell, or hub, shall be plastered with stiff cement mortar composed of one (1) part Portland cement and two (2) parts sand, of sufficient thickness to make the inner surfaces of the abutting sections, when laid, flush and even.

After each section of the pipe is laid and uniformly matched, the joint shall be entirely filled and packed with a stiff cement mortar composed of one (1) part Portland cement and two (2) parts sand. Sufficient additional mortar shall be used to form a bead around the joint. The joint on the inside of the pipe shall be filled with mortar of the same composition and finished smooth and even with the adjacent sections of pipe.

The filling around the pipe shall be made in layers not more than five (5) inches thick, and each layer shall be thoroughly tamped before the material for the next layer is spread. This filling and tamping shall be continued until there is a covering of not less than one (1) foot above the top of the pipe. No pavement or surfacing material shall be laid over any pipe until the backfill has thoroughly compacted and settled.

49.07 Method of Measurement: The footage to be paid for shall be the actual length in linear feet of pipe laid in place and accepted.

49.08 Basis of Payment: This item will be paid for at the contract unit prices bid for "Concrete Pipe" of the several sizes, which prices shall be full compensation for furnishing, hauling and installing the pipe, and for all materials, equipment, tools, labor and incidentals necessary to complete the work, but shall not be payment for concrete or masonry headwalls.

Payment will be made under

- Item 49-A, 12 inch Concrete Pipe (per linear foot)
- Item 49-B, 15 inch Concrete Pipe (per linear foot)
- Item 49-C, 18 inch Concrete Pipe (per linear foot)
- Item 49-D, 24 inch Concrete Pipe (per linear foot)
- Item 49-E, 30 inch Concrete Pipe (per linear foot)
- Item 49-F, 36 inch Concrete Pipe (per linear foot)
- Item 49-G, 42 inch Concrete Pipe (per linear foot)
- Item 49-H, 48 inch Concrete Pipe (per linear foot)

ITEM 50. CORRUGATED GALVANIZED METAL PIPE

50.01 Description: This item shall consist of furnishing and placing corrugated galvanized metal pipe conforming to these specifications. The pipe shall be furnished of the sizes and dimensions required and shall be installed at such places as shown on the plans or as designated by the Engineer in accordance with these specifications, and in conformity with the lines and grades given.

50.02 Materials: Corrugated metal pipe shall be fabricated from corrugated sheets, the base metal of which shall be made by the open hearth process. The base metal in the finished sheets shall conform to any one of the following sets of chemical requirements. The arrangement of types given below does not indicate preference and the choice shall be at the option of the contractor.

The base metal shall conform to the following chemical requirements:

CHEMICAL COMPOSITION

Position of base metals does not indicate preference

Elements	Pure Iron	Copper Bearing Pure Iron	Copper Iron	Copper Molybdenum Iron	Copper Steel	Tolerance by Check Analysis
Carbon Max.						
Manganese Max.						
Phosphorus Max. ....	.015	.015	.015	.015		
Sulphur Max. ....	.040	.040	.040	.040	.050	.010
Silicon Max.						
Copper Min. ....		.20	.20	.40	.20	.02
Molybdenum Min. ....				.05		
Sum of first five elements Max. ....		.10	.25	.25	.70	.04
Sum of first six elements Max. ....	.10					.04

50.03 Rivets: All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

50.04 Weight Tolerance: The average weight per square foot of the culvert sheets, as determined by weighing in lots not exceeding 6000 pounds, shall not vary from the theoretical weight by more than 5% either way for each lot of one gauge or size.

50.05 Spelter: The base metal sheets shall be uniformly galvanized on both sides by the hot process. A uniform coating of Prime Western Spelter shall be applied at the rate of not less than two (2) ounces per square foot of metal. If the average coating as determined from samples shows less than two (2) ounces of spelter per square foot of metal, or if any one sample shows less than 1.8 ounces of spelter per square foot of metal, the shipment shall be rejected. Sheets having blister spots, holes or other imperfections in the galvanizing after corrugating shall be rejected.

Bidders shall state in proposal the typical chemical composition, brand of metal, trade name, and name of manufacturer of the material to be furnished.

No metal will be accepted under these specifications and no bid will be considered for the materials above described until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the Engineer and accepted.

50.06 Branding: Misbranding or other misrepresentation, and non-uniformity of product, will each be considered a sufficient reason to discontinue the acceptance of any brand under these specifications, and the notice of discontinuance of any brand sent to the sheet manufacturer will be considered to be notice to any culvert companies which handle that particular brand.

50.07 Sheet Manufacturer's Certified Analysis: The manufacturer of each brand shall file with the Engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of each of the six above mentioned chemical elements. The certificate shall be sworn to for the manufacturing company by a person having legal authority to bind the company.

50.08 Sheet Manufacturer's Guarantee: The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge or spelter coating, and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

50.09 Identification: No culverts will be accepted unless the metal is identified by a stamp on each section showing:

- 1st, Name of sheet manufacturer
- 2nd, Name of brand
- 3rd, The gauge.

The identification brands shall be placed on the sheets by the manufacturers of the sheets, in such a way that when rolled into culverts such identification shall appear on the outside of each section of each pipe. Pipe having any section not so stamped shall be promptly rejected.

50.10 Laboratory Tests: Laboratory tests shall follow the methods of the U. S. Department of Agriculture Bulletin No. 1216, Revised, to date. The analysis made by the chemists or inspection bureau designated or approved by the Engineer shall be taken as final, but before any considerable shipment is rejected a check analysis shall be made.

50.11 Shape: Culverts furnished under these specifications shall be of the full-circle, riveted type, with lap-joint construction.

50.12 Dimensions and Weights: The lengths of sheets, widths of laps, gauge of the uncoated metal (United States standard gauge), and theoretical weight per linear foot of the finished culverts, shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per linear foot of a finished culvert, exclusive of end finish, shall not underrun the theoretical weight specified by more than five (5) per cent.

Nominal Diameter	Length of Sheet Before Forming	Width of Lap	Minimum Gauge U. S. Standard	Theoretical
				Weight per Linear Foot of Finished Culvert Exclusive of end Finish
Inches	Inches	Inches		Pounds
12	40	2.0	16	10.5
15	50	2.0	16	13.1
18	60	2.5	16	15.7
21	70	2.5	14	22.5
24	80	3.0	14	25.8
30	100	3.5	14	32.2
36	120	3.5	12	53.3

50.13 Corrugations: Corrugations shall be not less than $2\frac{1}{4}$ nor more than $2\frac{3}{4}$ inches center to center. The corrugations shall have a depth of not less than $\frac{1}{2}$ inch.

If the Engineer so elects he may have the material inspected at the rolling mill or the culverts inspected in the shop where they are fabricated. He may require a chemical analysis from the mill for any heat, also a physical test of the properties of the metal taken from any heat, to be made by the mill. The inspection both at the mill and at the shop shall be made under the direction of the Engineer. The Engineer, or his representative, shall have free access to the mill or shop for inspection purposes and every facility shall be extended to him for this purpose. Any material or pipe included in any shipment which has been rejected at the mill or shop will be considered sufficient cause for the rejection of the entire shipment.

50.14 Rivets and Riveting: Rivets shall have the following dimensions:

No. 16 gauge material (two thicknesses of sheets), $\frac{5}{16}$ by $\frac{1}{2}$ inch.

No. 14 gauge material (two thicknesses of sheets), $\frac{5}{16}$ by $\frac{5}{8}$ inch.

No. 14 gauge material (three thicknesses of sheets), $\frac{5}{16}$ by $\frac{3}{4}$ inch.

No. 12 gauge material (two thicknesses of sheets), $\frac{3}{8}$ by $\frac{3}{4}$ inch.

No. 12 gauge material (three thicknesses of sheets), $\frac{3}{8}$ by $\frac{7}{8}$ inch.

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. No rivet shall be closer than twice its diameter from the edge of the metal. All rivets shall have neat, workmanlike and full hemispherical heads, or heads of a form acceptable to the Engineer; shall be driven without bending; and must completely fill the hole. Longitudinal seams of thirty and thirty-six inch pipe shall be double riveted. Circumferential shop riveted seams shall have a minimum rivet spacing of six inches and shall lap at least one full corrugation, except that six rivets will be sufficient in twelve-inch pipe.

50.15 End Finish: If a band is used for end finish, it shall be riveted around the end of the culvert with rivets at intervals of ten (10) inches or less. This band shall be of galvanized metal equivalent in cross section to $\frac{3}{8}$ x 1 inch for 16-gauge metal, $\frac{3}{8}$ x $1\frac{1}{2}$ inches for 14-gauge metal and 12-gauge metal.

50.16 Joints: Field joints shall be made with bands of the same material as the culvert, and shall be not less than seven and one-half inches wide, so constructed as to lap an equal portion of each of the culvert sections to be connected. Such bands shall be connected at the ends by angles having minimum dimensions of $1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{1}{8}$ inch, and of length equal to full width of band, or by other approved connections of suitable strength. Each connection shall be fastened by at least two bolts not less than $\frac{1}{2}$ inch in diameter. All such connections shall be made of galvanized metal of the same quality as the base metal in the culvert.

50.17 Workmanship: It is the essence of these specifications that in addition to compliance with the details of construction, the completed pipe shall show careful, finished workmanship in all particulars.

Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which show defective workmanship, shall be rejected. This requirement applies not only to the individual pipe but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert pipe or in general in any shipment, shall constitute sufficient cause for rejection:

- Uneven laps
- Elliptical shaping
- Variation from a straight center line
- Ragged or diagonal sheared edges
- Loose, unevenly lined or spaced rivets
- Poorly formed rivet heads
- Unfinished ends
- Illegible brands
- Lack of rigidity
- Bruised, scaled or broken spelter coating
- Dents, or bends in the metal itself.

50.18 Field Inspection and Acceptance of Pipe: The field inspection shall be made by the Engineer, who shall be furnished by the contractor with an itemized statement of the sizes and lengths of culvert pipe in each shipment. This inspection shall include an examination of the culvert pipe for deficiencies in length of sheets used, nominal specified diameter, net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The inspection shall be made promptly upon notification by the contractor of the arrival of the material.

The pipe making up the shipment shall fully meet the requirements of these specifications, and if fifty per cent of the pipe in any shipment fails to meet these requirements the entire shipment may be rejected.

50.19 Sampling: When samples are taken for chemical analysis and determination of weight of spelter coating, at least one sample from which a specimen two and one-quarter inches square may be prepared shall be selected from each ten culverts of a shipment, and not less than three samples shall represent any one shipment.

50.20 Laying Pipe: Where the pipe is to be laid below the natural ground line, a trench shall be excavated to the required depth, and the bottom of the trench shall be shaped to conform to the bottom of the pipe, so as to afford a uniformly firm bed throughout its entire length. Where the pipe is not laid in a trench, a uniformly firm bed shall be made for the bottom of the pipe. All pipe shall be laid carefully and in conformity with the lines and grades given. Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and relaid by the Contractor without extra compensation. The filling around the pipe shall be made in layers not more than five inches thick, and each layer shall be thoroughly tamped before the material for the next layer is spread. No pavement or surfacing material shall be laid over any pipe until the backfill has thoroughly compacted and settled.

If, in the opinion of the Engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and back-filled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least four (4) inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material for the length of the culvert.

The pipe shall be laid in the trench with the separate sections firmly joined together and with outside laps of circumferential joints pointing up stream and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with suitable asphaltum paint.

50.21 Method of Measurement and Basis of Payment: This item shall be paid for at the contract prices bid per linear foot of "Corrugated Galvanized Metal Pipe" of the several sizes measured complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe, for preparation of bed and back-filling, and for all material, equipment, tools, labor and incidentals, but shall not be payment for concrete or masonry headwalls.

Payment will be made under

- Item 50-A, 12 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-B, 15 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-C, 18 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-D, 21 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-E, 24 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-F, 30 inch Corrugated Galvanized Metal Pipe (per linear foot)
- Item 50-G, 36 inch Corrugated Galvanized Metal Pipe (per linear foot)

ITEM 51. RELAYING CULVERT PIPE

51.01 Description: This item shall consist of the careful removal and preserving of pipe from existing pipe culverts as ordered, and relaying the same as shown on the plans or as designated by the Engineer, in accordance with these specifications for the type of pipe involved and in conformity with the lines and grades given.

51.02 Laying: Pipe shall be relaid in accordance with the structural details shown on plans, and in conformity with the requirements of the specifications applying to the particular kind of pipe to be relaid. All pipe, after removal from its original position, shall be thoroughly cleaned before being relaid.

51.03 Method of Measurement: This item shall be measured by the actual number of linear feet of pipe complete in place as required.

51.04 Basis of Payment: This item, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "Relaying Culvert Pipe" which price shall be full compensation for the removal, preservation, and relaying of the pipe, all new material necessary except pipe, all labor, equipment, tools, and incidentals necessary to complete the work, but shall not be payment for excavation or end-walls.

ITEM 52. CAST IRON PIPE

52.01 Description: This item shall consist of furnishing cast iron pipe, conforming to these specifications and of the sizes and dimensions required, and installing such pipe at such places as are designated on the plans or by the Engineer, and in conformity with the lines and grades given.

52.02 Materials: Cast iron pipe shall be of good quality, of the bell and spigot style, and all pipe shall be made of cast iron of such character as to be strong, tough and of even grain, and soft enough to admit of satisfactory drilling and cutting; the metal shall be made without any admixture of cinder iron and other inferior metal and the surface of the pipe shall be free from scales, lumps, blisters and holes, and other defects impairing its strength or utility; it shall be solid, round and cast vertical. It shall be in sections not less than 3 feet in length and with the inner and outer surfaces true concentric cylinders. It may be plain, smooth and straight cast iron water pipe or it may be approved corrugated cast iron or approved rib cast iron culvert pipe. Corrugations, when present, shall have a pitch of not more than 3 inches and a depth of not less than 1/2 inch. The pipe shall be heated to 300° F. and coated inside and outside by dipping in coal tar pitch or varnish.

The pipe shall have a minimum thickness and weight as shown in the following tables, and no pipe shall be accepted the weight of which is more than 5 per cent less than the weights given:

Plain Cast Iron Pipe

Inside Diameter Inches	Minimum Thick- ness, Inches	Weight per ft. Pounds
12	3/8	50
16	7/16	75
18	1/2	85
24	1/2	145
30	5/8	180
36	11/16	250

Corrugated or Ribbed Cast Iron Pipe

Inside Diameter Inches	Minimum Thick- ness, Inches	Weight per ft. Pounds
16	1/4	60
18	1/4	65
24	5/16	90
30	5/16	135
36	3/8	175

The pipe shall have sufficient strength so that when tested with the three edge standard crushing test as prescribed in the U. S. Department of Agriculture Bulletin 1216, Revised, to date, it will show a load supporting capacity in pounds per linear foot of at least 1500-D where "D" equals the inside diameter of the pipe in feet.

Each section of cast iron pipe shall be coated inside and outside with coal-tar pitch or varnish, to which sufficient linseed oil has been added to make a smooth coat, tough and tenacious when cold, with no tendency to scale off.

When required transverse test bars shall be furnished to determine the physical properties. The test bar shall be the 1" x 2" x 28" American Foundrymen's Association Standard rectangular bar. This bar shall be cast vertically in a dry sand mold, coated with a bituminous facing and not cast until the mold is cold. The test bar shall not be tumbled or otherwise treated but simply brushed off before testing.

The test shall be transverse with the bar placed horizontally upon supports twenty-four (24) inches apart and a concentrated load applied midway between the supports. The tests shall conform to the following requirements as a minimum:

Average load at the center.....2200 Pounds
Average deflection at center..... 0.30 Inches

From each melt, test bars shall be poured, the first one five (5) minutes after the first tap and then one (1) bar for each two (2) hour interval or fraction thereof, throughout the heat.

52.03 Laying: Where the pipe is to be laid below the natural ground line, a trench shall be excavated to the required depth, and the bottom of the trench shall be shaped to conform to the bottom of the pipe, so as to afford a uniformly firm bed throughout its entire length. Where the pipe is not laid in a trench, a uniformly firm bed shall be made for the bottom of the pipe. All pipe shall be laid carefully and in conformity with the lines and grades given. Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and relaid by the Contractor without extra compensation. The filling around the pipe shall be made in layers not more than five inches thick, and each layer shall be thoroughly tamped before the material for the next layer is spread. No pavement or surfacing material shall be laid over any pipe until the backfill has thoroughly compacted and settled.

If, in the opinion of the Engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and back-filled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least four (4) inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material for the length of the culvert.

Method of Measurement and Basis of Payment: This item shall be paid for at the contract prices bid per linear foot of "Cast Iron Pipe" of the several sizes measured complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe, for preparation of bed and back-filling, and for all material, equipment, tools, labor and incidentals necessary to complete the work, but shall not be payment for concrete or masonry headwalls.

Payment will be made under

Item 52-A, 12 inch Cast Iron Pipe (per linear foot)
Item 52-B, 16 inch Cast Iron Pipe (per linear foot)
Item 52-C, 18 inch Cast Iron Pipe (per linear foot)
Item 52-D, 24 inch Cast Iron Pipe (per linear foot)
Item 52-E, 30 inch Cast Iron Pipe (per linear foot)
Item 52-F, 36 inch Cast Iron Pipe (per linear foot)

ITEM 53. VITRIFIED CLAY PIPE

53.01 Description: This item shall consist of furnishing vitrified clay pipe, conforming to these specifications, and of the sizes and dimensions required, and installing such pipe at such places as are designated on the plans or by the Engineer, and in conformity with the lines and grades given.

53.02 Materials and Manufacture: Vitrified clay pipe shall be of the hub and spigot type, of first quality, sound, thoroughly and perfectly burned, without warps, cracks, or other imperfections, and shall be fully and smoothly glazed over the entire inner and outer surfaces, except that the inside of the hub and the outside of the spigot may be unglazed for two-thirds of the depth of the hub. On all other portions of the pipe, the glazing shall completely cover and form an integral part of the pipe body. If glazed, the inside of the hub and the outside of the spigot shall be scored in three parallel lines extending completely around the circumference. This pipe shall be manufactured at a suitable temperature to secure a tough, vitreous material which, when broken, shall show a dense and solid body without detrimental cracks or laminations. It shall be of such toughness that it may be cut with a chisel and hammer, and when struck with a hammer shall give a metallic ring.

The pipe shall have sufficient strength so that when tested with the three-edge standard crushing test as prescribed in the U. S. Department of Agriculture Bulletin 1216, Revised, to date, it will show a load supporting capacity in pounds per linear foot of at least 1500-D where "D" equals the inside diameter of the pipe in feet.

The minimum length of sections, thickness, and the depth of hub shall be as follows:

Size Inches	Minimum Length ft.	Thickness Inches	Depth of Hub Inches
12	2	1	3
15	2	1¼	3
18	2	1½	3¼
20	2	1⅝	3¼
22	2	1⅞	3¾
24	2	2	4
27	2½	2¼	4
30	2½	2½	4
33	2½	2⅝	5
36	2½	2¾	5
42	2½	3½	5

53.03 Laying: Where the pipe is to be laid below the natural ground line, a trench shall be excavated to the required depth, and the bottom of the trench shall be shaped to conform to the bottom of the pipe, so as to afford a uniformly firm bed throughout its entire length. Where the pipe is not laid in a trench, a uniformly firm bed shall be made for the bottom of the pipe. All pipe shall be laid carefully, hubs upgrade, spigot end fully entered into the adjacent hub, and in conformity with the lines and grades given.

If, in the opinion of the Engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and back-filled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least four (4) inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material for the length of the culvert.

53.04 Joints: Joints shall be filled with Portland cement mortar composed of one part Portland cement and two parts of clean, sharp sand. Mortar shall be thoroughly troweled in the recess in the interior of the pipe, and shall be placed over and around the entire joint. The joints shall be thoroughly wetted before making the mortar joint. Before succeeding sections of pipe are laid, the lower portions of the hub of the pipe shall be filled on the inside with cement mortar of sufficient thickness to bring the inner surfaces of the abutting pipes flush and even. After the pipe is laid the remainder of the joints shall be filled with mortar, and sufficient additional mortar used to form a bead around the joint. The inside of the joint shall be wiped and finished smooth. Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and relaid by the Contractor without extra compensation.

The filling around the pipe shall be made in layers not more than five inches thick, and each layer shall be thoroughly tamped before the material for the next layer is spread. No pavement or surfacing material shall be laid over any pipe until the backfill has thoroughly compacted and settled.

53.05 Method of Measurement: The footage to be paid for shall be the actual length of pipe laid in place and accepted.

53.06 Basis of Payment: Vitrified clay pipe, placed and accepted, shall be paid for at the contract unit prices per linear foot bid for "Vitrified Clay Pipe" of the several sizes, measured as provided above, which prices shall be full compensation for furnishing, hauling and installing the pipe, and for all materials, equipment, tools, labor and incidentals necessary to complete the work, but shall not be payment for concrete or masonry headwalls.

Payment will be made under

Item 53-A,	12 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-B,	15 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-C,	18 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-D,	20 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-E,	22 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-F,	24 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-G,	27 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-H,	30 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-I,	33 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-J,	36 inch	Vitrified Clay Pipe	(per linear foot)
Item 53-K,	42 inch	Vitrified Clay Pipe	(per linear foot)

LOUISIANA HIGHWAY COMMISSION

PAMPHLET "L"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

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- Item 60. Class "AA" Concrete.
 - Item 61. Class "A" Concrete.
 - Item 62. Class "B" Concrete.
 - Item 63. Class "C" Concrete.
 - Item 64. Water-Proofing.
 - Item 65. Catch Basins, Drop Inlets, Manholes.
 - Item 66. Reinforcing Steel.

- ITEM 60: CLASS "AA" CONCRETE
- ITEM 61: CLASS "A" CONCRETE
- ITEM 62: CLASS "B" CONCRETE
- ITEM 63: CLASS "C" CONCRETE

60.01 Description: Concrete shall be composed of Portland Cement fine and coarse aggregate, each measured separately and accurately by volume, unless otherwise specified, and water, mixed as provided in these specifications, and shall be constructed where, and of the form, dimensions, and design shown on the plans. Concrete shall be classified and proportioned by volume as follows, and in no event shall the number of bags of cement of 94 pounds each, used per cubic yard of concrete in place be less than the number required below :

Class of Concrete	Parts Aggregate to 1 Cement	Bags Cement to Cu. Yd.
AA	5	7.0
A	6	6.0
B	7½	5.0
C	9	4.2

The proportion of cement to aggregate for the several classes of concrete shall be approximately:

Class AA	1 - 5
Class A	1 - 6
Class B	1 - 7½
Class C	1 - 9

When the class of concrete required is not expressly indicated on the plans, the following requirements shall govern:

For slabs without wearing surface, Roadway Concrete Class "AA".

For slabs and girders with wearing surface, Class "AA" Concrete unless otherwise shown on plans or specified.

For reinforced concrete, except as otherwise provided for Class "A" concrete.

For arch rings, spandrel walls and buttresses, Class "A" concrete.

For plain concrete deposited under water to seal cofferdams Class "B" concrete with 25% additional cement added. All other concrete deposited under water shall be Class "A" with ten (10) per cent excess cement added.

For plain concrete abutments, wing walls and piers deposited in excavation free from water, Class "B" concrete.

For hand rails, Class "AA" concrete.

For ordinary materials, sand screened through a one-quarter (¼) inch sieve and aggregate of size as specified, the following are approximate quantities required per cubic yard of concrete:

Kind	Sand	Broken Stone
Class AA .....	.49	.74
Class A .....	.42	.84
Class B .....	.44	.87
Class C .....	.44	.89

The Engineer shall compare the amount of cement actually being used by the Contractor with the amount as prescribed herein and if the cement content is found low by more than two (2) per cent, the Contractor shall immediately modify his batch proportions so as to secure the cement content herein prescribed. The concrete shall be of satisfactory workability and no additional allowance shall be made to the Contractor for altered or increased materials.

60.02 Materials: The cement used for this work shall be of Portland Cement and shall conform to the requirements for Portland Cement of the latest specification of the American Society of Testing Materials.

Hydrated lime shall meet the requirements for Hydrated Lime of the American Society for Testing Materials, Serial Designation C-6-21T, Hydrated Lime, and when required shall be incorporated in the mixture in the amount specified. This amount given as a percentage of the cement, shall be treated as additional material and not as replacing any cement. Hydrated lime shall not be used in concrete deposited in water and shall not exceed ten (10) per cent by volume of the Portland Cement used.

Fine aggregate shall consist of sand or a combination of sand, and stone screenings, conforming to the requirements hereinafter specified.

Sand for fine aggregate shall consist of clean, hard, durable, uncoated particles, free from lumps of clay, soft or flaky material, loam, organic and other injurious matter. In no case shall fine aggregate containing lumps of frozen material be used. Where reinforcing is to be used sand shall be free from salt and alkali.

Stone screenings, either alone or in combination with sand, shall not be used as fine aggregate except by written permission of the Engineer.

60.03 Grading Fine Aggregate: This specification covers fine aggregate for cement concrete, for class "AA", "A", "B", "C", and for mortar.

Grading: Fine aggregate shall be uniformly graded from coarse to fine; and when tested by means of laboratory sieves shall meet the following requirements:

Passing a No. 4 sieve, not less than	95 %
Passing a No. 30 sieve	50 - 75 %
Passing a No. 50 sieve	5 - 30 %
Passing a No. 100 sieve	0 - 5 %

SAND FOR MORTAR

Passing a No. 8 sieve	100 %
Passing a No. 50 sieve	15 - 40 %
Passing a No. 100 sieve	0 - 10 %

Clay and Silt: Fine aggregate shall not contain more than 3% of material removable by the elutriation test.

All fine aggregate shall be free from injurious organic impurities. Aggregates subjected to the color test for organic impurities and producing a color in the sodium

hydroxide solution darker than the standard color shall be rejected unless subsequent mortar strength or concrete strength tests indicate them to be suitable for use.

Fine aggregate, when subjected to the mortar strength test, shall have a tensile or compressive strength at the age of seven (7) days and twenty-eight (28) days of not less than 100% of that developed by mortar of the same proportions and consistency, made of the same cement and standard Ottawa sand.

Fine aggregate conforming to all requirements except for grading and for organic impurities may be used, provided that concrete made from such material shall meet the requirements of the concrete strength test hereinafter specified.

60.04 Coarse Aggregate: The coarse aggregate for concrete shall consist of crushed stone or gravel, free from soft, thin elongated or laminated pieces, disintegrated stone, salt, alkali, vegetable or other deleterious matter.

Crushed stone shall be obtained from clean, tough, durable rock having a French Coefficient of wear of not less than seven (7).

Gravel for coarse aggregate shall consist of clean, tough, durable stones having a percentage of wear of not more than twenty (20) when tested in accordance with the method prescribed in Bulletin No. 1216, Revised to date, of the U. S. Department of Agriculture.

No bank run gravel shall be used.

Gravel containing disintegrated or soft stone or shale, or in excess of 5% of elongated or flat pieces, shall not be used. It shall be graded uniformly from the maximum size to pieces one-quarter ($\frac{1}{4}$) of an inch in diameter.

Wherever the material in a stockpile of coarse aggregate becomes segregated, due to the accumulation of the finer particles from successive shipments or other causes, the finer material shall be removed, screened or remixed with coarser particles to give the grading required by the specifications.

60.05 Grading Coarse Aggregate: The aggregate shall be graded uniformly from the maximum size to pieces one-quarter ($\frac{1}{4}$) inch in diameter. The maximum size will generally be given on the plans and the following grading requirements shall govern:

	Max- imum Size	Per Cent Passing Laboratory Screens						
		2½	2	1½	1	¾	½	No. 4
Class B and C Concrete.	2½"	100	90-100		40-70			0-5
Class A Concrete	1½"	100	100	100	85-100	40-85		0-5
Class A-A Concrete	1"	100	100	100	100		40-75	0-5

60.06 Forms: False work for supporting concrete work shall be built on foundations of sufficient strength to carry the load without appreciable deformation. Falsework which cannot be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to carry the full loads coming upon it. For single span bridges, falsework shall be given a permanent camber equal to one-twentieth ($\frac{1}{20}$) inch per foot of clear span. Multiple span bridges shall be given

the amount of camber specified on the plans. In general, double wedges or other suitable means shall be provided for constructing falsework and forms to correct lines. On important structures, when requested by the Engineer, the Contractor shall submit plans for falsework and forms for checking and approval before the falsework is constructed. No extra compensation will be allowed for falsework.

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

The material to be used in the forms for exposed surfaces shall be sized and dressed lumber, or metal in which all bolt and rivet heads are countersunk, so that in either case a plain, smooth surface of the desired contour is obtained. Undressed lumber may be used for backing or other unexposed surface.

The forms shall be built true to line, and braced in a substantial and unyielding manner. They shall be mortar tight, and, if necessary, to close cracks due to shrinking or age, shall be thoroughly soaked with water. Forms for reentrant angles shall be chamfered and for corners shall be filleted. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled, greased, or soaped to insure the non-adhesion of mortar. On retaining walls where coping is called for, the coping forms shall not be built until after the concrete has been placed in the wall and then they shall be braced and lined from the ground.

Form lumber which is to be used a second time shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete; and any bulging or warping shall be remedied and all dirt, sawdust, shavings or other debris within the form shall be removed.

No wood device of any kind used to separate forms shall be permitted to remain in the finished form.

60.07 Measuring: All materials shall be accurately measured by volume unless otherwise specified. The cement shall be measured as packed by the manufacturer, a sack containing not less than ninety-four (94) pounds net being considered one (1) cubic foot. Fine and coarse aggregate shall be measured loose. The Contractor shall furnish and use an approved water measuring and discharging device.

Measuring boxes of known capacity shall be used for both fine and coarse aggregate. These boxes can be of one or two cubic foot capacity and if flat bottom wheel barrows are used the boxes may have open bottoms so that they can be placed in a wheel barrow and filled exactly level full, and then raised leaving an accurately measured quantity in the wheel barrow. A cubic foot box is the most desirable size to use.

The practice of using a measuring box at the start of the day's work, making a crayon mark on the wheel barrow, and filling same to this mark thereafter will not be allowed. Aggregates used in every batch must be accurately measured.

60.08 Water Ratio: The quantity of water shall also be accurately controlled. This can be accurately and easily measured with buckets of known capacity. The amount of water required to secure compression strengths at 28 days called for in these specifications is as follows:

- Class AA 5½ gallons per sack of cement.
- Class A 6¾ gallons per sack of cement.
- Class B 7½ gallons per sack of cement.
- Class C 8 gallons per sack of cement.

Allowance must be made for free water in the aggregate as this becomes a part of the mixing water. Moisture in aggregate should be determined whenever possible or the following table may be used.

Approximate amounts of Free Water in Average Aggregate:

Condition of aggregate	Gallons per cu. ft.
Very wet sand	¾ to 1
Moderately wet sand	½
Moist sand	¼
Moist gravel or crushed stone	¼

Trial batches of concrete shall be made using the correct quantity of mixing water, to determine combination of aggregates which gives desired workability at least cost for material handling.

The mixture should be neither too dry nor too wet. It should puddle freely without segregation. Avoid undersanding, but use only that amount of sand or fine aggregate which will produce a smooth, workable mix.

The amount of mixing water shall not be increased from that given above. If the mix is too dry decrease the amount of fine and coarse aggregate and if too wet increase them.

60.09 Mixing Conditions: The concrete shall be mixed only in such quantities as are required for immediate use and any which has developed initial set, or has been mixed longer than forty-five (45) minutes, shall not be used. Bags of cement or fine aggregate containing lumps or crusts of hardened material shall not be used. No concrete shall be mixed while the air temperature is at or below thirty-five (35) degrees F.

60.10 Mixing Concrete: (a) Unless hand mixing is specifically permitted by the Engineer in writing, the mixing shall be done in a batch mixer of approved type and capacity which will insure the uniform distribution of the materials throughout the mass so that the mixture is uniform in color and smooth in appearance. The mixing shall continue for a minimum time of one and one-half (1½) minutes for Class "AA" and Class "A" concrete, and for a minimum time of one (1) minute for Class "B" concrete and Class "C" concrete, after all ingredients are assembled in the drum, during which time the drum shall revolve at the speed for which it was designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

(b) When hand-mixing is permitted it shall be done on a water-tight platform. The fine aggregate and cement shall first be mixed until a uniform color is attained and then spread over the mixing board in a thin layer.

The coarse aggregate, which shall have been previously drenched, shall then be spread over the fine aggregate and the cement in a uniform layer and the whole mass turned as the water is added.

After the water has been added the mass shall be turned at least four (4) times, and more if necessary, to make the mixture uniform in color and smooth in appearance. Hand mixed batches shall not exceed one-half ($\frac{1}{2}$) cubic yard in volume.

60.11 Character of Equipment: 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 by the Engineer. No change in the 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. In determining the capacity of mixers, the output per hour shall be considered as follows:

- 1 bag mixer — 3 cubic yards
- 1½ bag mixer — 5 cubic yards
- 2 bag mixer — 7 cubic yards
- 3 bag mixer — 10 cubic yards

The maximum continuous pouring for the various sized mixers, unless otherwise permitted by the Bridge Engineer, shall be as follows:

- 1 bag mixer — 35 cubic yards
- 1½ bag mixer — 50 cubic yards
- 2 bag mixer — 70 cubic yards
- 3 bag mixer — 100 cubic yards

The minimum size of mixer to be used on any work except pipe headwalls, shall be a one bag mixer. On pipe headwalls a one-half bag mixer may be used. Under special conditions and with satisfactory proof, the rating of the mixers, as stated above, may be increased.

60.12 Placing Concrete: Concrete shall be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach its final position in the form within 45 minutes after the time that water is first added to the mix. The method and manner of placing shall be such as to avoid the possibility of segregation or separation of the aggregates or the displacement of the reinforcement.

The use of long chutes for conveying concrete from the mixing plant to the forms will be permitted only on written authority from the Engineer. If chutes are allowed and the quality of concrete as it reaches the forms or the method of placing or working it therein are not satisfactory, the Contractor shall, upon orders from the Engineer, discontinue the use of chutes and re-equip his plant for placing the concrete in a satisfactory manner. Under no conditions shall this system be used on work exposed to the effects of salt or brackish water.

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 the 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 in the same manner that a tremie is used. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly

flushing with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Open 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 aggregate back from the face and to force the concrete under and around the reinforcement bars without displacing them. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

Concrete shall be compacted by continuous working with a suitable tool in a manner acceptable to the Engineer. Slab and girder work, arch ribs and all thin section work shall be thoroughly worked with a steel slicing rod. All faces shall be well spaded and the mortar flushed to the surface of the forms by continuous working with a concrete spading implement acceptable to the Engineer.

In all cases where, on account of the obstructions produced by reinforcement metal, shape of forms, or any other uncontrollable condition, difficulty is encountered in puddling the concrete adjacent to the forms, the mortar content of the mix shall be brought into proper contact with interior surfaces by vibrating the forms. The vibrations shall be produced by striking the outside surfaces of the forms with wooden mallets or by any other means satisfactory to the Engineer.

Concrete shall be placed in continuous horizontal layers, the thickness of which generally shall not exceed 10 to 12 inches. When it is necessary by reason of an emergency to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead. In any given layer the separate batches shall follow each other so closely that each one shall be placed and compacted before the preceding one has taken initial set, in order that the green concrete shall not be injured and that there shall be no line of separation between the batches. Each layer of concrete shall generally be left somewhat rough to secure efficient bonding with the next layer above. A succeeding layer placed before the underlying layer has become set shall be compacted in a manner that will entirely break up and obliterate the tendency to produce a construction joint between the layers.

Layers completing a day's work or placed just prior to temporarily discontinuing operations shall generally be cleaned of all objectionable material as soon as the surface has become sufficiently firm to retain its form. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be finished by being smoothed with a plaster mason's trowel.

Horizontal layers so located as to produce a construction joint at a location wherein a "feather edge" might be produced in the succeeding layer, shall be so formed by inset form work 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 temporarily discontinued within 18 inches below the top of any face, unless the details of the work provide for a coping having a thickness of less than 18 inches, in which case, at the option of the Engineer, the construction joint may be made at the under side of the coping.

After the concrete in finished surfaces has begun to set, it shall not be walked upon or otherwise disturbed in less than forty-eight (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 for the particular type of construction involved.

The operation of depositing and compacting the concrete shall in general be conducted so as to form a compact, dense, impervious, artificial stone of uniform texture which shall show smooth faces on exposed surfaces. If any section of concrete is found to be defective, it shall be removed or repaired as directed by the Engineer.

60.12 (a) 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.

Concrete deposited under water shall be carefully placed in a compacted mass in its final position by means of a tremie, a closed bottom dump bucket or other approved method 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 consistency of the concrete shall be carefully regulated and special care shall be exercised to prevent segregation of the materials. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces.

When a tremie is used, it shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the entire top surface of the work and shall be such as to permit it to be rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall be interrupted until the work is complete.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than $\frac{1}{2}$ cubic yard. The bucket shall be completely filled and lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

60.13 Bonding Construction Joints: In joining fresh concrete to concrete that has already set, the work already in place shall have its surface cut over thoroughly with a suitable tool to remove all loose and foreign material.

This surface shall then be washed and scrubbed with wire brooms and thoroughly drenched with water until saturated. It shall remain saturated until the new concrete is placed. Immediately prior to the placing of the new concrete, all forms shall be drawn tight against the concrete already in place and the old surface shall be thoroughly coated with a very thin coating of retempered mortar, neat cement or other suitable bonding material.

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 thoroughly saturated with water prior to insertion. Rough stone or steel dowels may, at the discretion of the Engineer, be used in lieu of keys. The size of spacing of keys and dowels shall be as determined by the Engineer. Specific requirements for the different types of construction shall be as specified under the various types.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, a metal baffle strip, preferably of copper, zinc or sheet lead, shall be inserted. This strip shall be placed not less than 3 inches from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2 inches.

60.14 Expansion Joints: Expansion and contraction joints in concrete structures shall be provided for as shown on the plans. For walls and long abutments, expansion joints shall be located at intervals not exceeding thirty (30) feet for plain walls, nor fifty (50) feet for reinforced walls. To be considered reinforced, the longitudinal steel shall be at least equal to one-half ($\frac{1}{2}$) of one (1) per cent of the cross sectional area of the wall.

Expansion joints in concrete walls and abutments shall be located where shown on the plans or directed by the Engineer. In order to maintain the proper alignment of the different parts of the work they shall be provided with keys of approximately $\frac{1}{3}$ the area of the cross-sections of the wall or with the equivalent thereof in dowels. Dowels if used shall be plain rounds coated with heavy oil and inserted into a metal sleeve at one end to provide room for movement.

60.15 Curing Concrete: Careful attention shall be given by the Contractor to the proper curing of the concrete. Hand rails, floors and trowelled surfaces shall be protected from the sun, and shall be kept wet for fourteen (14) days. Concrete floor slabs shall be covered with 2 inches of damp sand within 48 hours of pouring or ponded and in either case kept wet for from fourteen (14) to twenty-eight (28) days. Other precautions to insure thorough curing of the concrete shall be taken by the Contractor as directed by the Engineer.

60.16 Removal of Forms: In order to make possible the obtaining of a satisfactory surface finish, forms on ornamental work, railings, parapets, and vertical surfaces that do not carry loads and which will be exposed in the finished work shall be removed in not less than twelve (12) nor more than forty-eight (48) hours, depending upon weather conditions. Forms under slabs, beams, girders, and arches shall remain in place at least fourteen (14) days in warm weather, and in cold weather

21 days or at the discretion of the Engineer. Forms shall always be removed from columns, before removing shoring from beneath beams and girders, in order to determine the conditions of column concrete.

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. As soon as the forms are removed, all rough places, holes and porous spots shall be filled, and all bolts, wires or other appliances used to hold the forms and which pass through the concrete shall be cut off and set back one-half ($\frac{1}{2}$) inch below the surface and the ends covered with cement mortar of the same mix as used in the body of the work.

60.17 Defective Work: Any defective work discovered after the forms have been removed, shall be removed immediately and renewed. If the surface of the concrete is bulged, uneven or shows excess honey-combing of forms joint marks, which in the opinion of the Engineer, cannot be repaired satisfactorily, the entire section shall be removed and renewed. No compensation will be allowed for the work described above.

60.18 Drainage and Weep Holes: Drainage openings and weep holes shall be constructed in the manner and where indicated on the plans, or directed, and no additional allowance will be made for such work, except that no deduction will be made for such openings in payment for this concrete.

60.19 Placing Pipes and Conduits: Pipes and conduits which are to be encased in the concrete as shown on the plans, shall be placed by the Contractor during construction. Such pipes and conduits will be delivered to the Contractor, unless otherwise stated, at the site of the structure by the Department or by other Departments or persons for whose use they are intended. No compensation will be made for placing such pipes, conduits, etc., except that no deductions will be made for the volume occupied by them.

60.20 Placing Anchors, Bolts, Grillages, Etc.: The Contractor shall place all anchors, bolts, grillages, etc., securely and accurately in the locations shown on the plans or as otherwise required. No compensation will be made for placing such anchors, bolts, grillages, etc., as may be furnished at the bridge site by the Department. The cost of placing those included in the approximate estimate for the "Structural Steel" items will be included in the contract prices for those items. No deduction will be made for the volume of concrete occupied by any of the materials specified above.

60.21 Finishing: All exposed concrete shall be true, even, free from open spaces, depressions, or projections. The concrete in all walls, shall be brought flush with the finished top surface and generally shall be struck off with a straightedge and floated. Mortar finish shall not be permitted. The surface finish of all the exposed concrete shall be "Spaded," "Rubbed," or "Tooled," as indicated on the plans, but when not so specifically indicated, the Contractor shall make a spade finish on all surfaces.

The spade finish shall be obtained by forcing a flat blade vertically down between the concrete and the form and then by pulling the top of the spade from the form so that the mortar will, in all cases be on the finished surface.

Rubbed finish shall be made by rubbing the surface previously spaded, with a soft brick or block of wood, while the concrete is still green or by rubbing with a block of carborundum after the concrete has set. Care should be observed to use plenty of water, either by dipping the brick or block in water, or by throwing water on the concrete with a brush or broom.

Tooled finish shall be made on the surface, previously spaded by cutting into the body of the concrete with a pointed tool or bush hammered as indicated.

Cement wash will not be permitted.

60.22 Side Walks and Curbing: When a granolithic finish is called for on the plans for a sidewalk, this finish shall be one (1) inch in depth and composed of one (1) part of Portland Cement and one (1) part of stone grit as specified. The surface shall be screened and floated, then dotted and grooved and divided into blocks approximately four (4) feet square. Suitable provisions shall be made for expansion. The granolithic mixture shall be placed within thirty (30) minutes after the concrete base has been placed. The curbing shall be of the dimensions and construction indicated on the plans, and the expansion joints shall be constructed where indicated. This sidewalk and curbing will be paid for as indicated herein.

60.23 Stone Grit: Stone grit shall consist of clean, dustless screenings, resulting from the crushing of tough, durable rock, having a French coefficient of wear of not less than seven and one-half ($7\frac{1}{2}$) at least equal in quality to stone specified for coarse aggregate, which shall be prepared by screening through a revolving screen having circular opening not larger than three-eighths ($\frac{3}{8}$) of an inch in diameter and by passing over a disk jacket. Not more than twenty-five (25) per cent, by weight, shall pass a standard No. 50 laboratory sieve, nor more than five (5) per cent shall pass a No. 100 sieve.

60.24 Strength: Mortar composed of one (1) part, by weight, of Portland Cement and three (3) parts, by weight, of stone grit shall have a tensile strength at the age of seven (7) and twenty-eight (28) days of not less than one hundred and twenty-five (125) per cent of that developed by mortar or the same proportions and consistency, made of the same cement and a standard Ottawa sand.

60.25 Refilling: All areas which have been excavated as specified under "Excavation and Embankment," the volume of which is not occupied by the concrete structure, shall be refilled with acceptable materials in layers of not more than six (6) inches in depth, each layer being tamped thoroughly before the succeeding layer is placed.

60.26 Concrete Strength Requirements: Concrete materials shall be submitted to the following test when required by Engineer, and shall be considered to pass the concrete strength test when the following strength requirements are fulfilled:

The coarse aggregate, fine aggregate and cement and water proposed for use, shall be mixed in the same proportions and to the same consistency that they are to be used in the work, and tested as prescribed in U. S. Department of Agriculture Bulletin No. 1216, revised to date, and at least the following compression strengths shall be obtained, for the several classes:

	1-5	1-6	1-7½	1-9
7 Day test	1800	1600	1300	1000
28 Day test	2800	2200	1700	1500

On large or important structures, samples of concrete materials, or of the concrete may be required for testing purposes. If required, these samples shall be supplied to the Engineer free of charge. Material shall be delivered far enough in advance of using to allow the Engineer to select samples and to forward them to the laboratory for testing. The laboratory will usually need at least ten days for 7-day tests and 31 days for 28-day tests.

CONCRETE BRIDGES

60.27 Description: All concrete bridges shall be built as indicated on the plans, conforming to lines, grades, dimensions, and designs shown, and in accordance with the specifications for piling, concrete, reinforcing steel, and other pay items which are to constitute the complete structure.

60.28 Materials: Materials used shall be those prescribed for the several items which constitute the structure.

60.29 General Construction Methods: Changes: The Contractor shall during construction adhere strictly to the plans, as the strength of the finished structure depends upon this; and no change shall be allowed without the written authority of the Engineer.

60.30 Foundations: All foundations shall be inspected and approved by the Engineer previous to placing any concrete. All excavation shall be carried to such a depth that foundation materials satisfactory to the Engineer are found, regardless of the elevation shown on the plans, and unsuitable material shall be replaced with approved material if required. If rock bottom is secured, the excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the masonry. All loose and disintegrated rock or thin strata shall be removed. In general all footings except those on solid rock, shall be carried to a depth of at least four feet below the permanent bed of the stream, and to such additional depth as will eliminate the danger of undermining. All foundations, where practicable, shall be constructed by open excavation and the foundation openings shall be shored, braced, or protected by cofferdams. Wherever possible, all foundations excavation shall be pumped dry and concrete deposited in the open. If it is impossible to proceed, as above outlined, a seal of concrete of sufficient thickness to resist any possible uplift shall be deposited under water as herein elsewhere required.

When footings can be placed in the dry without the use of cribs or cofferdams, backforms may be omitted at the discretion of the Engineer and the entire excavation filled with concrete to the required elevation of the top of the footing.

Piling shall be used when footings cannot, in general and at a reasonable expense, be carried to rock or other solid material.

60.31 Concrete Floors: Concrete floors for all bridges, whether steel trusses, steel stringers or concrete girders, shall be constructed and finished according to these specifications and shall be built of Class "AA" concrete unless otherwise shown on plans or specified. The thickness shall not be less than six (6) inches.

60.32 Swinging the Span: Before concrete floors are placed on steel spans, the centering under the bridge shall be released and the span swung free on its supports.

60.33 Forms: The forms for the curb, both inside and out, shall be two inch lumber, the inside form for the curb to be supported from the floor on concrete blocks

the thickness of the floor, or by small cleats nailed to the form and extending to the floor; these cleats to be taken off after the floor is concreted and the templates have passed. This inside curb shall be wired to the outside form with two wire twisters at two foot centers with one wire twister two inches from the top of the curb and the other one inch from the bottom of the curb.

The outside curb form shall be supported both from the lower chord and from the bottom flange of the outside stringer. This shall be very rigid and tied across the top of the outside stringer to the forms between the stringers to keep it from moving out. This may also be accomplished by punching holes in the top flange of the outside stringer four feet on centers for $\frac{3}{4}$ inch bolts with the nut up so that the bolt may be removed.

60.34 Placing Reinforcement: All reinforcement shall be rigidly wired at intersections and suitable provision shall be made for supporting it in position during the placing of concrete. This may be accomplished by the use of cement blocks. No concrete shall be deposited until the reinforcement is in place and has been inspected and approved by the Engineer. The placing of any reinforcement during the process of placing the concrete will not be permitted. Splices, when permitted, shall be made at points of least tension in the steel.

60.35 Placing Concrete: The operation of placing the concrete in any floor slab shall be continuous between expansion joints.

On steel truss spans the concrete shall be placed symmetrically about the center line of the span, beginning at the center and working simultaneously toward each end, or beginning at the ends and working simultaneously toward the center, the latter method shall be used for swing bridges. Care shall be taken to prevent the displacement of reinforcement during the placing of concrete.

If for any reason it becomes necessary to introduce a construction joint, this shall be formed by means of a vertical bulkhead so constructed as to produce a keyed or dove-tailed joint. In concrete floors not supported by longitudinal joists, any necessary construction joints shall be located at the center of the slab span.

In placing concrete around steel shapes it shall be placed only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which it shall be placed on both sides to completion.

60.36 Expansion Joints: Concreting over each span shall be completed in a continuous operation. Expansion shall be provided between spans and under each end of floors resting on the abutments. These joints shall be filled with tar or asphalt or felt as shown on the drawings.

At expansion joints the edges of the concrete shall be protected by steel plates approved by the Engineer and the joints shall be filled with an asphaltic felt. The centering under the steel trusses of swing bridges shall be lowered and the trusses swung free on their own bearing, before the concrete is run for the floor.

60.37 Templates: There shall be two (2) templates, the first one made out of two 2 x 10's cut to the camber of the road and resting on the inside curb form. The templates should be 4 inches shorter than the roadway between curbs so that they

may be easily moved. They should be provided with handles or ropes so that they can be held vertical and pulled. This template is to be kept right up with the concreting and be pulled by the men placing the concrete.

The second template should be made out of one 2 x 10 cut to the camber of the road and supported on the inside form of the curb, this template to be pulled by two men doing the finishing, who shall see that the curb is filled and struck off level and who shall also pull the second template about six feet at a time and then finish back of the template with a long handled wooden float. They shall take care that the concrete is pulled away from the bottom of the curb so that the drain will be open and also that the correct crown is left in the floor. They will usually be able to follow about one panel behind the big template. The top of the curb shall be finished as the floor is placed. These templates shall be trussed so that the curve produced on the roadway shall at all times conform to the dimensions given on the plans.

The wooden float may be made of a 1 x 6 inch, two and one-half feet long, with corners rounded and an eight foot handle to hold it at any angle desired by the workmen.

60.38 Curing the Floor: The floor shall be covered within 48 hours of pouring with two inches of sand or ponded and kept wet for from 14 to 28 days.

60.39 Removing Forms: The curb forms shall be removed in the summer time within 24 hours after the concrete is placed and in the fall and winter within 48 hours or at least as soon as they may be removed without damaging the curb. Any holes in the curb or air pockets shall be filled with cement mortar at once. This to be left rough for several hours and then rubbed smooth with the surface. The forms for the floor shall remain on fourteen (14) days in the summer and twenty-one (21) days in the fall and winter or at the discretion of the Engineer.

60.40 Finishing: The curb shall be finished both inside and out with a carborundum stone. The top of the curbs shall be finished smooth with a trowel and the corners neatly rounded to a $\frac{3}{4}$ -inch radius. As soon as the forms are removed the curb shall be wetted with a brush using clear water. This water shall be changed frequently so that it is always clean. As soon as the curb is wetted with a brush for a couple of feet, it shall be rubbed. A film will be noticed and some air bubbles. This is the carborundum finish and should be followed and gone over with a brush after it has been dried. It will be an even color and will turn white and set hard.

60.41 Basis of Payment: Concrete floors shall be paid for at the contract unit price, which price will include all concrete, drains, forms, equipment, tools, labor and work incidental thereto. The reinforcement shall be paid for separately and at the contract unit price per pound for reinforcement.

ARCHES

60.42 Plans: Arches shall be constructed in accordance with the designs and dimensions shown on the plans or as directed.

60.43 General: Materials shall meet the requirements of, and the work shall be done in accordance with, the "General Requirements for Concrete and Methods of Construction."

60.44 Class of Concrete: Unless otherwise noted on the plan the footings, abutments and piers, shall be Class "B" Concrete, and arch rings and ribs, Class "A" Concrete. All other portions of the work, unless otherwise noted, if reinforced, shall be Class "A" Concrete, and unreinforced shall be Class "B" Concrete.

60.45 Falsework: Centering shall be built on a good firm foundation. Generally piling shall be driven to support the falsework for arches. The centering shall be of such strength and be so rigidly braced as to insure the complete arch having the curvature shown on the plans. If, during construction, any weakness develops or the centering shows undue settlement or distortion, the work shall be stopped and any masonry affected thereby removed, and the centering strengthened before work is resumed. Centering shall be constructed so as to permit of its being gradually and uniformly lowered. Other devices than ordinary falsework used to support centers and the centering and falsework for large arches and for structures composed of a series of arches shall be submitted and approved prior to construction of same.

60.46 Lagging: Lagging for concrete arches shall be surfaced lumber preferably tongued and grooved and shall be mortar tight.

60.47 Striking Centers: Centers shall be gradually and uniformly lowered in such manner as not to produce injurious stresses in any part of the structure. In favorable weather, centers shall remain in place under arches for at least 28 days. In structures of two or more arches the sequence of striking centers will be stated in the special provisions or shall be approved by the Engineer before work is commenced. In unfavorable weather, centers shall remain in place under all arches as long as the Engineer may deem necessary.

60.48 Details of Construction: The arch ring shall not be concreted until the fill around the abutments has been carried up to the skewback. Arch rings shall preferably be cast in a single continuous operation but where this is impracticable they may be divided, by vertical bulkheads, into longitudinal sections or by radial bulkheads into transverse sections of such size that each section can be cast in continuous operation. Transverse sections shall be so arranged that initial stress will not be created in the reinforcement. In either method work shall be carried on symmetrically about the crown of the arch and the section shall be keyed or doweled together as the Engineer directs. The spandrel wall or spandrel filled arches or deck of open spandrel arches shall be cast after centers are lowered. The railing shall not be placed until the centers are lowered. For large arches and for structures composed of two or more arches the Contractor shall prepare plans showing the sections and giving the sequence of concreting that he proposes to use, which plans shall be approved before this part of the work is started. Extrados of arch rings and inside face of spandrel shall be left smooth to receive the waterproofing.

60.49 Waterproofing: Unless otherwise specified the top of the arch ring and the inside face of the spandrel walls of all spandrel filled arches shall be waterproofed, using the membrane method specified under "Waterproofing" paragraphs.

60.50 Drainage: On all spandrel filled arches, drains shall be provided with suitable pipe drain outlets at all piers, and generally at abutments. For open spandrel arches, drainage shall be provided as shown on the plans.

60.51 Filling: Unless otherwise specified, the filling over arches above the skewback excepting backfilling, will not be included in the contract for structures. Filling when done shall be placed simultaneously at both ends of all arches. It shall be deposited in horizontal layers not more than 6 inches thick and thoroughly compacted by ramming. Wedge shaped sections of loose earth or other material against spandrels, wings and abutments will not be permitted. Filling shall not be deposited against "green concrete."

DESIGN

60.52 Dimensions: The following dimensions shall be used in designing super-structures:

Span of concrete slab, distance center to center of supports or clear span plus depth of slab.

Span of beam or girder, distance center to center of bearings.

Span of arch, horizontal distance between intersection of neutral axis and skewback.

Rise of arch, vertical distance between neutral axis at highest point and a horizontal line through the intersection of the neutral axis with the skewback.

LOADING

60.53 Dead Loading: Detailed plans submitted under these specifications shall provide for the following loadings:

The dead loading includes the weight of the structure, floor and fill, using the following unit weights:

Steel Sections as given in hand books:

Stone	160 pounds per cu. ft.
Reinforced Concrete	150 pounds per cu. ft.
Brick	150 pounds per cu. ft.
Asphalt	150 pounds per cu. ft.
Gravel	140 pounds per cu. ft.
Macadam	140 pounds per cu. ft.
Earth Filling	100 pounds per cu. ft.
Timber, Pine and Fir	4 pounds per ft. B. M.
Oak	5 pounds per ft. B. M.
Creosoted Timber	5 pounds per ft. B. M.

The dead load used in figuring stresses must not vary more than 5 per cent from the actual estimated weight for the completed design.

60.54 Live Loads: Live loads considered shall be either the traffic lane load designated hereinafter or a concentrated live load, depending upon which gives the most unfavorable condition of loading. The truck dimensions and weight distribution used for design purposes shall be those of the typical or standard truck shown in the following sketch. This standard truck is designated by the letter "H", followed by a numeral indicating its gross or total weight in tons.

The class of loading used shall be the following :

Loading H15. 15 ton trucks.

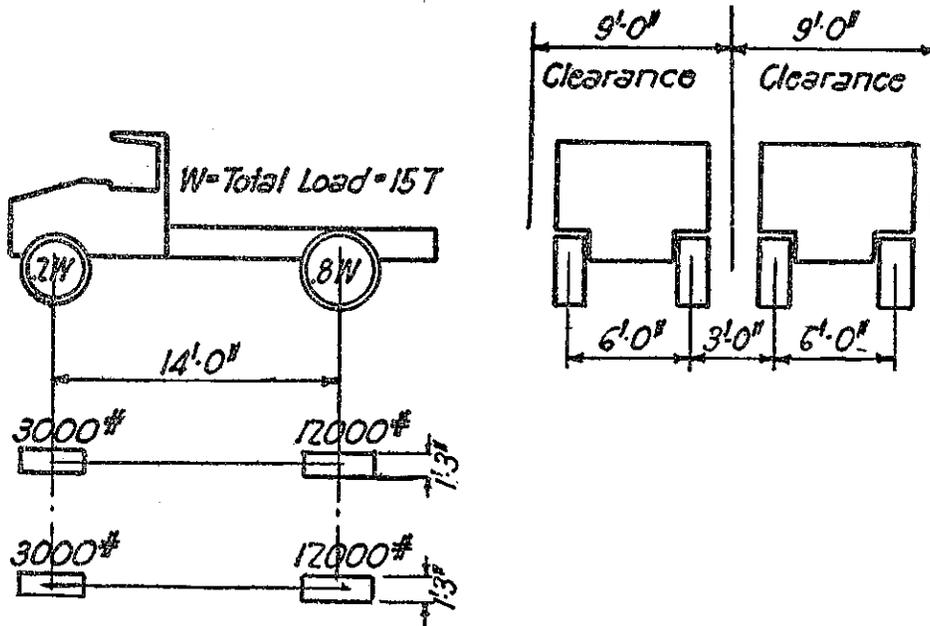


Fig. II
STANDARD TRUCK

60.55 Highway Loads for Girders: The girders of bridge spans and the columns of viaduct towers and bents shall be designed for the stresses produced by a load on each traffic lane composed of a uniform load per linear foot of lane with a concentrated load so located longitudinally therein as to produce maximum stresses. The concentrated load shall be considered as uniformly distributed transversely on a line having a length equal to the width of the lane. The standard truck clearance width of 9 feet shall be assumed as constituting the width of one traffic lane.

The class of loading used shall be the following :

Loading H15. A total load on each traffic lane composed of a uniform load of 450 lbs. per linear foot and a single concentrated load of 21,000 lbs.

60.56 Application of Loads to Girders: Girders shall be designed to support as many traffic lanes as the width of roadway will permit, assuming them to be placed symmetrically with regard to the roadway center line.

To provide for an increase in girder stresses resulting from the passage of eccentrically placed loads and for a decrease in traffic lane intensity for increasing widths of roadway, the stresses obtained by the application of the above loading shall be multiplied by the coefficient "C" given by the following formula :

$$C = \frac{18 + W}{18n}$$

Where W = the width of roadway for bridges with two main girders or the distance center to center of girders for bridges with more than two main girders.

Where n = number of lanes of traffic.

60.57 Application of Loads to Floor System: Bridge floor systems shall be designed to support as many trucks, not exceeding four, as the width of roadway will permit.

When the design of the floor system involves the placing of trucks adjacent to curbs, the extreme position of a truck shall be assumed as that in which the center of the outside wheel is 1'-6" from the inside edge of the curb.

In the design of floor beams and their supports the following percentages of the resultant live load stresses shall be used:

One or two trucks	100 per cent
Three trucks	90 per cent
Four trucks	80 per cent

60.58 Sidewalk Loads: All sidewalk stringers and brackets shall be designed to support a live load of not less than 100 pounds per square foot of sidewalk area.

Girders supporting sidewalks shall be designed to support a sidewalk live load as determined by the following formula, provided that in no case shall the live load be less than 20 pounds per square foot of sidewalk area:

$$P = (80 - 0.125L) \times (1 - 0.025W)$$

Where P = live load in pounds per square foot of sidewalk area.

Where L = loaded length of sidewalk in feet.

Where W = clear width of sidewalk in feet.

No impact increment shall be added to sidewalk load.

In general, provision shall be made to prevent the encroachment of roadway loads upon the sidewalk area. Whenever the details of the structure permit such encroachment, the sidewalks shall be designed for the roadway loads and impacts so involved.

60.59 Impact: On masonry or concrete structures where the fill is over one (1) foot, no impact allowance will be made. When the fill is less than one (1) foot an allowance for impact shall be made to the extent of thirty (30) per cent of all live load stresses.

60.60 Distribution of Wheel Loads: Each wheel load of the typical 15 ton truck shall be assumed to be distributed as follows:

Concrete Floor Slabs and Slab Culverts Under Shallow Fills: In calculating bending stresses due to wheel loads on concrete slabs, no distribution in the direction of the span of the slab shall be assumed. In the direction perpendicular to the span of the slab, the wheel load shall be considered as distributed uniformly over a width of slab which is known as the "effective width."

In the following equations let

E = effective width in feet for one wheel.

S = span of slab in feet.

W = width of wheel or tire in feet.

X = distance in feet from the center of the near support to the center of wheel.

Case I. Main Reinforcement Parallel to Direction of Traffic:

$$E = 0.7 S + W$$

For this case the value of E shall not exceed 7 feet.

When two wheels are so located on a transverse element of the slab that their effective widths overlap, the effective width for each wheel shall be $\frac{1}{2} (E + a)$ when "a" is the distance between centers of wheels.

Case II. Main Reinforcement Perpendicular to Direction of Traffic:

$$E = 0.7 (2 x + W)$$

For this case the bending moment on a strip of slab one foot in width shall be determined by placing the wheel loads in the position to produce maximum bending; determining the effective width for each wheel; and assuming the load delivered by each wheel to the one foot strip to be the wheel load divided by its respective effective width.

This design assumption does not provide for the effect of loads near unsupported edges. Therefore, at the ends of the bridge and at intermediate points where the continuity of the slab is broken, the edges of the slab shall be supported by diaphragms or other suitable means.

The edge of slab bridges shall be strengthened by curbs cast integral with the slab, or by other means, so proportioned that the outermost 3'-0" of the slab including the curb will be capable of supporting three-quarters of any concentrated load that can come near the edge.

60.61 Culverts Under Fills: Where the depth of cover (fill and pavement) is 3'-0" or over, concentrated loads shall be considered as uniformly distributed over a square, the sides of which are equal to $1\frac{3}{4}$ times the depth of cover. When such areas from several concentrations overlap, the total load shall be considered as uniformly distributed over the area defined by the outside limits of the individual areas, but the total width of distribution must not exceed the total width of the slab. When the depth of cover exceeds 10 feet, the live load may be disregarded.

60.62 Permissible Stresses: The stresses used in designing slab, girder and arch bridges shall not exceed the following except as noted below in parentheses. All unit stresses are given in pounds per square inch.

Concrete. Direct Compression. Columns reinforced with longitudinal bars and separate lateral ties.....	600-15 L/D
but not to exceed	450
where L = unsupported length of column	
D = least diameter of column	
Piers and Pedestals	450

Compression Due to Bending.	
Beams and slabs	650
Arch rings, including temperature and rib shortening.....	800
Tension	Zero
Shear (Diagonal Tension)	
Beams without shear reinforcement,	
Longitudinal bars not anchored	40
Longitudinal bars anchored	60
Beams with shear reinforcement	120
Punching Shear	120
Bearing on Bridge Seats. Bearing on concrete masonry, lime- stone masonry and better	
	500
Reinforcement: Tension. Beams and slabs	
	16,000
Arch rings, including temperature and rib shortening.....	20,000
Compression — 15 times stress in surrounding concrete.	
Bond—	
Bars not anchored	80
Bars adequately anchored by hooks or otherwise.....	120

(Note: The above allowable unit stress values for concrete and for bond on reinforcement are based on an ultimate compressive strength value of 2200 pounds per square inch at the age of 28 days when tested in accordance with the tests as prescribed in the U. S. D. A. Bulletin No. 1216, Revised to date.

When the aggregates used and the laboratory and field control of concrete mixtures are such that a uniformly higher ultimate compressive strength is insured, then the above unit stresses may be increased by a maximum of 15% for concrete having an ultimate strength of 2800 pounds per square inch or more at the age of 28 days and proportionately for intermediate values of ultimate strength, except that the stress due to bending in arch ribs when the effects of temperature and rib shortening are included shall in no case exceed 800 pounds per square inch.

When economy may be obtained by the use of aggregate which will result in concrete having a lower ultimate strength than 2200 pounds per square inch at the age of 28 days, the above unit stresses shall be reduced in the proportion that the lower ultimate strength in pounds per square inch bears to 2200.)

60.63 Bearing Power of Soils: For the design of foundations, the following unit bearing values may be assumed in the absence of definite information as to the actual bearing power of the foundation in question. In this tabulation it is intended to cover only broad basic groups of materials and to specify for these a maximum range in bearing power. These groups may be further subdivided to provide for special conditions:

Material	Safe Bearing Power Tons per Sq. foot
Alluvial Soils	½ to 1
Earth and soft clay	1 to 2
Clay and sandy clay	2
Sand or gravel confined	2
Cemented gravel	5
Rock cleaned to solid bed to 25 tons per sq. ft.	

Foundation Soil: The soil material upon which piers and abutments must be founded is divided into the following:

- (a) Soft ground, such as soft or wet clay, silt or mud, where the sustaining power must largely depend on the frictional resistance of piles or of piling driven through the soft ground to an underlying material of a harder character.
- (b) Hard ground, such as hard-pan, gravel, or compacted sand held laterally and hard dry clay.
- (c) Rock.

60.64 Expansion Joints: Slab and Girder Bridges. Expansion joints shall be left between the abutments and floor slabs or girders. Two layers of three-ply roofing felt shall be used for such joints, unless otherwise specified. For girders over thirty (30) feet in length some means for providing free movement shall be employed.

60.65 Expansion Joints: Arch Bridges. Expansion in spandrels shall be provided for, over springing lines of the arches. The railings shall have expansion joints at intervals of not over fifteen (15) feet.

REINFORCEMENT

60.66 Spacing: The spacing of parallel bars shall not be less than 3 diameters, center to center, with a minimum clearance between bars of 1¾ inches.

The minimum covering, measured from the surface of the concrete to the face of any reinforcing bar, shall be not less than 2 inches, except in slabs and culverts where the minimum covering shall be 1 inch. In the footings of abutments and retaining walls and in piers the minimum covering shall be 3 inches. In work exposed to the action of sea water the minimum covering shall be 4 inches except in precast concrete piles where a minimum of 3 inches may be used.

60.67 Splicing: Tensile reinforcement shall not be spliced at points of maximum stress. When reinforcement is spliced, the spliced bars shall lap sufficiently to develop the full strength in bond.

60.68 Anchorage: Anchorage of longitudinal reinforcement may be provided by extending the bars a sufficient distance beyond the theoretical point of termination to develop their full strength in bond. Anchorage may also be provided by bending the end of the bar through 180 degrees to a diameter not less than 6 times the diameter of the bar, the total length of the hook being not less than 16 diameters of the bar.

Reinforcement for negative moment shall be thoroughly anchored at or across the support, or shall extend into the span a sufficient distance to develop by bond the tensile stresses.

60.69 Maximum Sizes: The maximum size of bar reinforcement shall be $1\frac{1}{4}$ inches square or equivalent, unless the particular conditions warrant the adoption of special reinforcement design. When structural steel shapes are used for reinforcement, no section having a surface area per foot of length of more than 150 square inches shall be used as a reinforcing member unless mechanical bond is provided by means of lugs, bars or other details which will effectively bond the member to the surrounding concrete mass.

60.70 Design of Web Reinforcement: When the allowable unit shearing stress for concrete is exceeded, web reinforcement shall be provided by one of the following methods:

- (a) Longitudinal bars bent up in series or in a single plane.
- (b) Vertical stirrups.
- (c) Combination of bent-up bars and vertical stirrups.

When any of the above methods of reinforcement are used, the concrete may be assumed to carry external vertical shear not to exceed 40 pounds per square inch, the remainder of the shear being carried by the web reinforcement.

The webs of T-beams shall be reinforced with vertical stirrups in all cases.

60.71 Bent-Up Bars: Bent-up bars used as web reinforcement may be bent at any angle between 20 and 45 degrees with the longitudinal reinforcement. The radius of bend shall not be less than 4 diameters of the bar.

The spacing of bent-up bars shall be measured perpendicular to their direction and in a plane parallel to the longitudinal axis of the beam. This spacing shall not exceed $\frac{3}{4}$ of the effective depth of the beam. The first bar from the support shall cross the neutral axis of the beam at a distance from the face of the support, measured along the axis of the beam, not greater than $\frac{1}{4}$ of the effective depth.

60.72 Vertical Stirrups: The spacing of vertical stirrups shall not exceed $\frac{3}{4}$ of the effective depth of the beam. The first stirrup shall be placed at a distance from the face of the support not greater than $\frac{1}{4}$ of the effective depth of the beam. Stirrups shall surround three sides of the tensile reinforcement.

60.73 Anchorage: Web reinforcement shall be securely anchored in the compression portion of the beam, which may be considered as developing bond for a vertical distance equal to $\frac{4}{10}$ the effective depth of the beam. Stirrups and bent-up bars shall be securely anchored to the tensile reinforcement.

SUBSTRUCTURES, RETAINING WALLS AND CULVERTS

60.74 Description: All concrete and masonry culverts, all pipe culverts, end walls, abutments and retaining walls shall be built as indicated on the plans conforming to the line, grade, dimensions and designs shown, and in accordance with the specifications for concrete masonry and pipe of the several varieties and other pay items which are to constitute the completed structures.

60.75 Materials: The concrete, reinforcing steel, structural steel, masonry and other materials shall meet the requirements contained herein for the class of concrete or other materials to be used.

Construction Methods: These structures shall be constructed in accordance with the specifications contained herein for the kinds of work being done and conforming to the lines, grades, measurements and designs shown on the plans.

60.76 Foundations: All foundations shall be inspected and approved by the Engineer previous to placing any masonry or footing. All excavations shall be carried to such a depth that foundation materials satisfactory to the Engineer are found regardless of the elevations shown on the plans, and unsuitable material shall be replaced with approved material, if required. If rock bottom is secured, the excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the masonry. All loose and disintegrated rock shall be removed.

Footings, floors of paved culverts, and abutment walls shall be so designed as to distribute the loads over the full length and width of the main wall foundations. The pressure on ordinary soils shall not exceed $1\frac{1}{2}$ tons per square foot average or three tons per square foot maximum for abutment, wing or pier footing. Wing footings shall not be considered as taking any of the superstructure load.

PILES

60.77 Use of Piling: In general, piling shall be used when footings cannot, at a reasonable expense, be founded on rock or other solid foundation material. In streams where erosion is possible, piling preferably shall be used (if possible to drive) as a protection against scour, even though the safe bearing resistance of the natural soil is sufficient to support the structure without piling.

60.78 Design Loads: Preferably, structures shall be proportioned to limit the maximum design load on timber piles to 15 tons per pile. In no case shall they be designed to support more than 22 tons per pile. The maximum design load on concrete piles may be assumed as from 25 to 35 tons per pile, depending on conditions.

Piles shall be designed to carry the entire superimposed load, neglecting impact, no allowance being made for the supporting value of the material between the piles.

The supporting power of piles shall be determined by the application of test loads or by the use of formulas.

60.79 Spacing: Footing area shall be so proportioned that pile spacing shall be not less than 2'6", center to center. The distance from the side of any pile to the nearest edge of the footing shall be not less than 9 inches.

60.80 Batter Piles: When it is necessary to use piles under arch abutments, batter-piles shall be used.

60.81 Concrete Piles: Precast concrete piles shall be in accordance with the plans and these specifications. Piles for hard driving preferably shall be shod with a metal shoe of approved pattern.

FOOTINGS

60.82 Depth: The depths of footings shall be determined with respect to the character of the foundation materials and the possibility of undermining. Except where solid rock is encountered or in other special cases, the footings of all structures, other than culverts, which are exposed to the erosive action of stream currents preferably shall be founded at a depth of not less than four feet below the permanent bed of the stream. Stream piers and arch abutments preferably shall be founded at a depth of not less than six feet below stream bed. The above preferred minimum depths shall be increased as conditions require.

Footings not exposed to the action of stream currents shall be founded on a firm foundation and at a depth below frost.

Footings for culverts shall be carried to an elevation sufficient to secure a firm foundation, or a heavy reinforced floor shall be used to distribute the pressure over the entire horizontal area of the structure. In any location liable to erosion, apron or cut-off walls shall be used at both ends of the culvert and, where necessary, the entire floor area between the wing walls shall be paved. Baffle walls or struts across the unpaved bottom of a culvert barrel shall not be used where the stream bed is subject to erosion. When conditions require, culvert footings shall be reinforced longitudinally.

Footings on solid rock, unless they are restrained by an over-burden of resistant material, shall be effectively anchored by means of anchorbolts, dowels, keys or other suitable means.

60.83 Distribution of Pressure: All footings shall be designed to keep the maximum soil pressures within safe bearing values. In order to prevent unequal settlement, footings shall be designed to keep the pressure as nearly uniform as practicable. In footings having unequal pressures and requiring piling, the spacing of the piles shall be such as to secure as nearly equal loads on each pile as may be practicable.

60.84 Internal Stresses in Spread Footings: Spread footings shall be considered as under the action of downward forces due to the superimposed loads, resisted by an upward pressure exerted by the foundation material and distributed over the area of the footings as determined by the eccentricity of the resultant of the downward forces. Where piles are used under footings, the upward reaction of the foundation shall be considered as a series of concentrated loads applied at the pile centers, each pile being assumed to carry its computed proportion of the total footing load.

Footings shall be designed for bending stresses, for diagonal tension stresses, and for punching shear around the periphery of the column or pier shaft. The critical section for bending shall be taken at the face of the column wall or pier shaft. Bending need not be considered unless the projection of the footing is more than two-thirds the depth.

When a single spread footing supports a column, pier or wall, the footing shall be assumed to act as a cantilever. When two or more piers or columns are placed upon a common footing, the footing slab shall be designed for the actual conditions of continuity and restraint.

60.85 Reinforcement: Footing slabs shall be reinforced for bending stresses and, where necessary, for diagonal tension. All bars shall be effectively anchored to develop in bond the computed stress in the bar.

The reinforcement for square footings shall consist of two or more bands of bars. The reinforcement necessary to resist the bending moment in each direction in the footing shall be determined as for a reinforced concrete beam; the effective depth of the footing shall be the depth from the top to the plane of the reinforcement. The required reinforcement shall be spaced uniformly across the footing unless the footing width is greater than the side of the column or pedestal plus twice the effective depth of the footing, in which case the width over which the reinforcement is spread may equal the width of the column or pedestal plus twice the effective depth of the footing plus one-half the remaining width of the footing. In order that no considerable area of the footing shall remain unreinforced, additional bars shall be placed outside of the width specified, but such bars shall not be considered effective in resisting the calculated bending moment. For the extra bars a spacing double that used for the reinforcement within the effective belt may be used.

When reinforcement is used in more than one direction the allowable unit bond stresses shall be reduced as follows:

For two-way reinforcement	25%
For each additional direction	10%

60.86 Transfer of Stress From Vertical Reinforcement: The stresses in the vertical reinforcement of columns or walls shall be transferred to the footings by extending the reinforcement into them a sufficient distance to develop the strength of the bars in bond, or by means of dowels anchored in the footings and overlapping or fastened to the vertical bars in such manner as to develop their strength. If the dimensions of the footings are not sufficient to permit the use of straight bars, the bars may be hooked or otherwise mechanically anchored in the footings.

ABUTMENTS

60.87 Design: Abutments shall be designed to withstand earth pressure, the weight of abutment and superstructure, live load over any portion of the superstructure or approach fill and wind forces. The design shall be investigated for any combination of these forces which may produce the most severe condition of loading.

Abutments shall be designed to be safe against overturning about the toe of the footing, against sliding on the footing base and against crushing of foundation material or overloading of piles at the point of maximum pressure.

In computing stresses in abutments, the weight of filling material directly over an inclined or stepped rear face, or over a reinforced concrete spread footing extending back from the face wall, may be considered as part of the effective weight of the abutment. In the case of a spread footing the rear projection shall be designed as a cantilever supported at the abutment stem and loaded with the full weight of the superimposed material. In no case shall an abutment be designed for less than an equivalent fluid pressure of 30 pounds per cubic foot, having the same depth as the fill.

The cross section of stone masonry or plain concrete abutments shall be proportioned to avoid the introduction of tensile stress in the material.

60.88 Reinforcement for Temperature: Except in gravity abutments, not less than one-eighth (0.125) square inch of horizontal reinforcement per foot of height shall be provided near exposed surfaces not otherwise reinforced, to resist the formation of temperature and shrinkage cracks.

60.89 Wing Walls: Wing walls shall be of sufficient length to retain the roadway embankment to the required extent and to furnish protection against erosion. For ordinary materials, in the absence of accurate data, the slope of the fill shall be assumed as one and one-half ($1\frac{1}{2}$) horizontal to one (1) vertical and wing lengths computed on this basis.

Reinforcing rods or other suitable rolled sections preferably shall be spaced across the junction between all wing walls and abutments to thoroughly tie them together. Such bars shall extend into the masonry on each side of the joint far enough to develop the strength of the bar as specified for bar reinforcement. If bars are not used, an expansion joint shall be provided at this point in which the wings shall be mortised into the body of the abutment.

60.90 Drainage: The filling material behind abutments shall be effectively drained by weep holes with French drains, placed at suitable intervals.

RETAINING WALLS

60.91 Design: Retaining walls shall be designed to withstand earth pressure, including any live load surcharge and the weight of the walls, in accordance with the general principles specified above for abutments.

Stone masonry and plain concrete walls shall be of the gravity type. Reinforced concrete walls may be of either the cantilever, counterforted, buttressed, or cellular types.

60.92 Base of Footing Slabs: The rear projection or heel of base slabs shall be designed to support the entire weight of the superimposed material. The base slabs of cantilever walls shall be designed as cantilevers supported by the wall.

The base slabs of counterforted and buttressed walls shall be designed as fixed or continuous beams of spans equal to the distance between counterforts or buttresses.

60.93 Vertical Walls: The vertical stems of cantilever walls shall be designed as cantilevers supported at the base.

The vertical or face walls of counterforted and buttressed walls shall be designed as fixed or continuous beams.

The face walls shall be securely anchored to the supporting counterforts or buttresses by means of adequate reinforcement.

60.94 Counterforts and Buttresses: Counterforts shall be designed as T-beams. Buttresses shall be designed as rectangular beams. In connection with the main tension reinforcement of counterforts there shall be a system of horizontal and vertical bars or stirrups to effectively anchor the face wall and base slab. These stirrups shall be anchored as near the outside faces of the face walls, and as near the bottom of the base slabs as practicable.

60.95 Expansion Joints: Expansion joints shall be provided at intervals not exceeding 30 feet for gravity walls and 50 feet for reinforced walls.

60.95 (a) Drainage: The filling material behind all retaining walls shall be effectively drained by weep holes with French drains placed at suitable intervals. In counterforted walls there shall be at least one drain for each pocket formed by the counterforts.

60.96 Piers: Piers shall be designed to withstand the dead and live loads superimposed thereon; wind pressures acting on the pier and superstructure; forces due to stream current and floating drift.

CULVERTS

(This specification covers only reinforced box culverts)

60.97 Class of Concrete: Unless otherwise specified, all reinforced concrete culverts shall be of Class "A" concrete except the footings which may be of either Class "A" or Class "B" concrete as specified.

Gravity sections used for wings and culvert barrel walls shall be of either Class "A" or Class "B" concrete as specified.

60.98 Construction Method: If deemed necessary, in order to prevent scour, the Engineer may direct that the space between the wings be paved. In this event, the apron walls will extend in a straight line between the ends of the wings, or at such location as may afford the best protection.

60.99 Drainage: Adequate drainage of fills around culverts shall be insured by the construction of weep holes, French drains, or under-drains.

60.100 Method of Placing Concrete: In general, the base slab or footings of box culverts and 6" of the sidewalls will 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 chipped and roughened in accordance with the method of bonding construction joints as specified under "Concrete".

In the construction of box culverts four (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 four (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.

60.101 Surface Finish: Unless otherwise specified, all copings, railings, and the exposed faces of wing walls and slabs shall be finished in accordance with the requirements set forth under "Concrete."

**METHOD OF MEASUREMENT AND BASIS OF PAYMENT
FOR ALL CONCRETE STRUCTURES**

60.102 Method of Measurement: The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications, unless changes are ordered during construction, for the several pay items. No deduction will be made for panels less than six (6) inches wide. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

No direct payment will be made for excavating and disposing of the materials required to be moved, in order to build the structure, as the cost of this work shall be included in the prices bid for the construction of the structure.

60.103 Basis of Payment: The measured quantities, as provided above, will be paid for at the contract prices bid for the several items, which prices shall be full compensation for furnishing, hauling and placing all materials, and for all labor, equipment, tools, and necessary incidentals. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, additional cement used in concrete placed under water, falsework, form lumber or other erection expenses.

No extra compensation will be made for the construction of granolithic sidewalks and curbs in conjunction with structures or for expansion joints in the concrete but all will be measured and paid for at the contract price per cubic yard of the adjacent concrete.

Reinforcing material will be paid for as indicated under section on "Reinforcement."

When a special finish is required it will not be paid for as a separate item but is to be included in the price bid per cubic yard for concrete. No extra compensation will be allowed for finishing defective work.

Whenever the construction of the new structures involves the removal or demolition of an existing structure unless otherwise expressly provided, such removal or demolition shall not be paid for directly, but shall be considered as subsidiary work pertaining to excavation or to prescribed pay items involved in the work.

Payment will be made under:

Item No. 60	Class "AA"	Concrete per cu. yd. complete in place.
Item No. 61	Class "A"	Concrete per cu. yd. complete in place.
Item No. 62	Class "B"	Concrete per cu. yd. complete in place.
Item No. 63	Class "C"	Concrete per cu. yd. complete in place.

ITEM 64. WATERPROOFING

64.01 Description: Reinforced concrete shall be water-proofed when called for on the plans or directed. Waterproofing may be either the integral or membrane type. The kind to be used will be stated on the plans or in the special provisions.

INTEGRAL METHOD

64.02 Material: The material used in the integral method of waterproofing shall consist of hydrated lime as specified. Other waterproofing compounds may be used if approved by the Engineer.

Method of Using: The hydrated lime to the amount of 10% by volume of cement shall be mixed with water to the consistency of cream and added to the mixing water or may be mixed dry with the cement before it is poured into the mixer. The concrete shall be deposited continuously so far as possible. Where construction joints are necessary, a continuous sheet of zinc the full length of the joint and extending 6 inches into the concrete on each side of the joint shall be used. Where expansion joints are waterproofed, the work shall be done in accordance with the detail plans or as directed.

Waterproofing compounds including hydrated lime, shall be treated as an addition and not as replacing any of the cement.

MEMBRANE METHOD

64.03 Material: The material shall consist of asphalt, meeting the following requirements:

Note: All tests shall be made in accordance with the methods described or referred to in tentative specifications for Asphalt for use in Damp-proofing and waterproofing of the American Society of Testing Materials, Serial Designation D-40.

Asphalt: This asphalt shall have a melting point of not less than 54.5 degrees C., nor more than 60 degrees C. The penetration at 25 degrees C., under load of 100g for 5 seconds shall not be less than 50 or more than 75. The ductility at 25 degrees C, when a bricquette of the material having a minimum cross-section of 1 sq. cm. is pulled apart at the rate of 5 cm. per minute, shall not be less than 30 cm. The sp. gr. at 25 Degrees C., shall not be more than 1.08. Not less than 95 per cent of the asphalt shall be soluble in cold carbon bi-sulphide. The loss on heating at 163 degrees C. for 5 hours shall not exceed 1 per cent and the penetration of the residue shall not be less than 50 per cent of the original penetration. The mineral ash shall not exceed 4 per cent.

Primer for Asphalt: This primer shall consist of an asphaltic base, complying in every respect with the requirements for asphalt for waterproofing, which shall be thinned to ordinary paint consistency with a petroleum distillate having an end point on distillation not above 260 degrees C. Not more than 20 per cent of this petroleum distillate shall distill under 120 degrees C.

64.04 Method of Using: On surfaces to be waterproofed all projections shall be dressed off and the outside film of cement removed by brushing with wire brushes and washing with clean water. When the concrete is thoroughly dry, and not less

than 21 days old, the entire surface to be waterproofed shall be covered with a coat of the primer, applied cold. The surface shall then be given two coats of the waterproofing applied while hot, with mops. The coatings shall be well rubbed in all corners and recesses and shall be continuous throughout. The total thickness of the waterproofing shall be approximately $\frac{1}{4}$ inch. Where expansion joints are waterproofed the work shall be done in accordance with the detail plans or as directed.

BASIS OF PAYMENT

64.05 Integral Method: Payment for this work, including all materials, equipment and work incidental thereto, shall be included in the prices bid for concrete.

Membrane Method: This work will be paid for at the contract unit price per square yard for "waterproofing," complete in place, which price will include all materials, equipment, tools, labor and work incidental thereto. This payment will be for the actual area of surface covered.

Payment will be made under:

Item 64, "Waterproofing per sq. yd."

ITEM 65. CATCH BASINS, DROP INLETS AND MANHOLES

65.01 Description: Catch basins, drop inlets and manholes shall consist of cement concrete and reinforcement if necessary, and the necessary metal frames and covers or gratings, all constructed as shown on the plans and in accordance with the specifications. The concrete and reinforcement shall meet the requirements as outlined in these specifications.

65.02 Materials: Castings for frames, covers, gratings, etc., shall be composed of best quality tough gray iron free from cold shuts, blowholes or other imperfections. The castings shall be sound, true to form, thickness and weight, clean and neatly finished, and shall be coated with coal-tar pitch varnish.

65.03 Construction: Castings for catch basins, drop inlets and manholes shall be set in full mortar beds, or otherwise as shown on the plans.

Inlet and outlet pipes shall extend through walls for a sufficient distance beyond the outside surface to allow for connections, and concrete shall be constructed around them neatly, and so as to prevent leakage along their outer surface.

65.04 Basis of Payment: "Catch Basins", "Drop Inlets" and "Manholes", Item 65, will be paid for at the contract unit price, each complete in place, which price will include the required frames and covers, or grating, and other fittings all necessary excavation and back filling, and all materials, forms and labor incidental thereto.

Inlet and outlet pipes shall be measured with the adjoining pipe and paid for at the contract unit price per linear foot.

ITEM 66. REINFORCING STEEL

66.01 Description: Under this item, reinforcing steel of the type, size and quantity designated shall be furnished and placed in concrete structures as required by these specifications and shown on the plans.

All reinforcement shall consist of deformed bars, plain bars, expanded metal, wire cloth or structural steel shapes.

Bars shall be classified as Deformed or Plain. Deformed bars shall consist of bars of an approved deformed type such that a mechanical bond will be provided between the concrete and steel at frequent intervals. Square twisted bars are not considered to have such mechanical bond. The size shall be such that the minimum net sectional area of the bar shall be equal to the section of a plain bar of the nominal size indicated.

66.02 Materials: Unless otherwise specified reinforcing steel shall be structural steel or intermediate grade and shall meet the requirements of the standard specifications for Billet Steel Concrete Reinforcement Bars of the American Society for Testing Materials, Serial Designation A-15-24.

No re-rolled or high carbon steel will be accepted.

Where purchased from ware-houses in small lots, reinforcement may at the discretion of the Engineer be accepted subject to the bending test only.

Structural shapes used for reinforcement shall be in accordance with the specifications for structural steel as herein elsewhere prescribed.

66.03 Construction Methods: All reinforcement, when placed, shall be free from mill-scale, loose or thick rust, dirt, paint, oil or grease and shall present a clean surface.

When bending is required, it shall be accurately and neatly done. When fabrication is required it shall be done in the shop and not in the field. All reinforcing shall be placed in the exact position shown on the plans, and shall be held firmly in position by means of approved metal spacers, premoulded concrete block supports and separators spaced as shown on the plans, by wiring to the forms and by wiring together at all intersections by approved wire ties so that it will not be displaced during the depositing and compacting of the concrete.

The placing and fastening of reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section.

Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the location of the splices shall be submitted and approved before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress; they shall, where possible, be staggered; and shall be designed to develop the strength of the bar. Where spliced by lapping, the bars shall be securely wired together and the lap shall be long enough to develop the strength of the bar without exceeding a bond stress of 80 pounds per square inch.

No welds will be allowed.

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No allowance will be made for clips, metal spacers, ties, etc., wire or other material used for fastening reinforcing steel in place, except that wire hoops used in reinforced concrete columns and encased I-beams or similar construction when included in the bill of material.

66.03 Basis of Payment: The reinforcing steel used, unless otherwise specified, will be paid for at the contract price per pound, which price will include the furnishing and placing of the material and all equipment, tools, labor and work incidental thereto.

Payment will be made under :

Item 66 Deformed Reinforcing Steel per pound complete in place.

Item 67 Plain Reinforcing Steel per pound complete in place.

LOUISIANA HIGHWAY COMMISSION

PAMPHLET "M"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

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- Item 70. Fabricated Structural Steel.
 - Item 71. Plain Structural Steel.
 - Item 72. Gas Pipe Handrail.

SECTION 70. STEEL BRIDGES

70.01 Description: All steel structures shall be built as indicated on the plans, conforming to line, grade, dimensions and design shown, and in accordance with the specifications for Piling, Concrete, Masonry, Structural Steel and other pay items which are to constitute the completed structure, and in conformity with such specifications prescribed under Concrete Bridges as are involved.

70.02 Materials and Construction Methods: Materials and Construction methods used shall be those prescribed for the several items which are to constitute the structure and in addition shall conform to the following requirements:

MATERIALS

70.03 General: All structural, rivet and eyebar steel shall conform to the requirements of the Standard Specifications for Structural Steel for Bridges, Serial Designation A 7-24, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society, and supplemented by the following paragraphs:

70.04 Character of Fracture: Test specimens of structural, rivet or eyebar 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.

70.05 Defects in Material: Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength and durability.

70.06 Full-Size Tests: When full-size tests of built up structural members or eyebars are required by the contract the Contractor shall supply testing machines of the proper type and capacity and shall provide all facilities and labor incidental to the making of tests. In all tests involving the determination of tensile and compressive strengths the ultimate strength, deformation and other pertinent data shall be recorded.

70.07 Payments for Full-Size Tests: Any full-size member tested to destruction shall be paid for by the Purchaser at the unit contract price, less its scrap value, if the test proves satisfactory. If the test proves the member to be unsatisfactory, the members represented by it will be rejected. The expense of conducting tests shall be borne by the Contractor unless otherwise provided.

EYE BARS

70.08 Full-Size Tests: When tests of full-size bars are required the following conditions and requirements shall supplement the general provisions of Section 70.03 to 70.07 inclusive.

70.09 Number and Size of Test Bars: The number and size of the bars to be tested shall be designated by the Engineer before the mill order is placed. The

number shall not exceed 5 per cent of the whole number of bars ordered, with a minimum of two bars on small orders.

70.10 Selection of Test Bars: The test bars shall be of the same section as the bars to be used in the structure and of the same length if within the capacity of the testing machine. They shall be selected by the Inspector from the finished bars, preferably after annealing. Test bars representing bars too long for the testing machine shall be selected from the full-length bar material after the heads on one end have been formed and shall have the second head formed upon them after being cut to the greatest length which can be tested.

70.11 Physical Requirements: Full-size tests of eyebars shall show a yield point of not less than 29,000 pounds per square inch, an ultimate strength of not less than 55,000 pounds per square inch, and an elongation, including fracture of not less than 10 per cent in a length of 20 ft. measured in the body of the bar. The fracture shall show a uniform silky or fine granular structure throughout.

70.12 Failure to Meet Requirements: If a bar fails to fulfill the specified requirements, two additional bars of the same size and from the same melt shall be tested. If the failure of the first bar tested is on account of the character of the fracture only, the bars represented by the test may be reannealed before the additional bars are tested.

If two of the three test bars fail to give satisfactory results, the bars of that size and melt shall be rejected.

In general, test bars shall be so selected that every melt of material entering into the various sizes of bars shall be represented by at least one test.

A failure in the head of a bar shall not be cause for rejection if the other requirements are fulfilled.

70.13 Annealing Record: A record of the annealing charges shall be furnished the Engineer showing the bars included in each charge and the treatment they received.

STEEL FORGINGS

70.14 General: Steel forgings from which pins, rollers, trunnions, or other forged parts are to be fabricated, shall conform to the requirements of the Standard Specifications for Carbon-Steel Forgings for Locomotives, Serial Designation A20-21, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

70.15 Annealing: All forgings shall be thoroughly annealed prior to being machined to form finished parts.

WROUGHT IRON

70.16 Wrought-Iron: Wrought-iron shall conform to the requirements of the Standard Specifications for Refined Wrought-Iron Bars, Serial Designation A41-18, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

STEEL CASTINGS

70.17 General: Steel castings shall conform to the requirements of the Standard Specifications for Steel Castings, Serial Designation A-27-24, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society, and supplemented by the following:

Unless otherwise specified all castings shall be Class B, Medium Grade.

70.18 Annealing: All steel castings shall be thoroughly annealed unless otherwise provided.

70.19 Structural Defects: Steel 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.

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 one foot, nor shall any single blow hole exceed one inch in any dimension or have an area greater than one-half square inch. Blow holes shall not have a depth injuriously affecting the strength of the casting. 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 castings shall be annealed, if required by the Engineer. Castings which have been welded without the Engineer's permission shall be rejected.

Large castings, if required by the Engineer, shall be suspended and hammered all over. No cracks, flaws or other defects shall appear after such treatment.

No sharp unfileted angles or corners will be allowed.

GRAY-IRON CASTINGS

70.20 General: Iron castings shall conform to the requirements of the Standard Specifications for Gray-Iron Castings, Serial Designation A48-18 of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

70.21 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 the service intended.

MALLEABLE CASTINGS

70.22 General: Malleable castings shall conform to the requirements of the Standard Specifications for Malleable Castings, Serial Designation A47-24, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

The castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

70.23 Structural Defects: Malleable castings shall be true to pattern in form dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended.

PHOSPHOR-BRONZE

70.24 Phosphor-Bronze for Bearing Plates: Phosphor-Bronze shall be a homeo-geneous alloy of crystalline structure. It shall be made of new metals, except that clean scraps of known composition may be used. It shall not contain sulphur. The phosphorus shall be introduced in the form of phosphor-tin or phosphor-copper. Cast-ings shall be sound, clean and free from blow holes, porous places, cracks and other defects.

Phosphor-Bronze for bearing plates shall be planed top and bottom.

70.25 Composition of Phosphor-Bronze: Phosphor-Bronze shall have the fol-lowing composition:

	Per Cent
Copper	84 to 86
Tin	4 to 6
Zinc	4 to 6
Lead	4 to 6
Phosphorous, not more than.....	0.5
Other elements, not more than.....	0.5

INSPECTION AND TESTING

70.26 Inspection and Testing: The purchaser under these specifications shall be furnished by the manufacturer with every facility for complete inspection and tests and shall on request be supplied with copies of the full orders, melt numbers, manufacturer's melt analysis and shipping invoices both from the mill and from the fabricating shop.

70.27 Starting Work: The Engineer shall be notified well in advance of the Rolling date and also when the work will start in the shop in order that he may have an inspector present to inspect material and workmanship.

70.28 Inspection: When an inspector is furnished by the Engineer he shall have full access, at all times, to all parts of the shop where material under his inspec-tion is being manufactured. The manufacturer shall furnish all facilities for in-specting, the quality of workmanship, checking the weights and, when required, shall furnish a suitable testing machine for testing full sized members.

70.29 Inspector's Authority: The Inspector shall have the power to reject ma-terials or workmanship which do not fulfill the requirements of these specifications; but in cases of dispute the Contractor may appeal to the Engineer, whose decision shall be final.

Inspection at the mill and shop is intended as a means of facilitating the work and avoiding errors, and it is expressly understood that it will not relieve the Con-tractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing the same.

70.30 Cost of Testing: Unless otherwise provided, the Contractor shall furnish, without charge, test specimens as specified herein, and all labor, testing machines and tools necessary to prepare the specimens and to make the full-size tests.

70.31 Accepting Material: The inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time and at any stage of the work. If the inspector, through an oversight or otherwise, has accepted material or work which is defective or contrary to the plans or specifications, this material, no matter in what stage of completion, may be rejected by the Engineer.

70.32 Rejected Material and workmanship shall be replaced promptly or made good by the Contractor.

70.33 Field Inspection: All work of erection shall be subject to the inspection of the Engineer who shall be given all facilities required for a thorough inspection of workmanship.

Material and workmanship not previously inspected will be inspected after its delivery to the site of the work.

FABRICATION

70.34 Changes and Substitutions: All parts forming a structure shall be built in accordance with approved drawings.

No changes shall be made in any drawing after it has been approved except by the consent or direction of the Engineer in writing.

Substitutions of sections having different dimensions than those shown on the plans shall be made only when approved in writing by the Engineer.

70.35 Straightening: Material shall be thoroughly straightened in the shop by methods that will not injure it before being laid off or worked in any way. Sharp kinks and bends shall be cause for rejection.

70.36 Members to Be Straight: The several pieces forming one built member shall be straight and fit closely together, and finished members shall be free from twists, bends, open joints, or other injurious defects.

70.37 Workmanship and Finish: The workmanship and finish shall be first class and equal to the best practice in modern bridge shops. Shearing and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

70.38 Finish of Joints: Abutting joints shall be cut or dressed true and straight and fitted close together, especially where open to view.

70.39 Column Ends Milled: For trestle bents the ends of the column sections shall be milled to take full contact bearing upon caps and base plates. The holes for anchor bolts shall be slotted a proper amount for expansion and contraction.

70.40 Compression Splices Milled: The abutting surfaces of all compression joints shall be neatly and accurately faced, and after they are riveted up completely and perfectly aligned, shall have full contact bearing.

70.41 Lattice Bars: Lattice bars shall have neatly rounded ends, unless otherwise indicated.

70.42 Web Stiffeners Shall Fit Neatly Between Flanges of Girders: When tight fits are required, the ends of stiffeners shall be faced and shall be brought to a true contact bearing with the flange angle.

70.43 Connection Angles: Connection angles for floor beams and stringers shall be flush with each other and correct as to position and length of member. Connection angles shall be milled when called for on plans. In milling not more than $\frac{1}{8}$ " thickness shall be removed from any angle.

70.44 Punching: Full-size punched holes shall be one-sixteenth inch ($\frac{1}{16}$ ") larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than three thirty-seconds inch ($\frac{3}{32}$ "). Holes must be clean cut, without torn or ragged edges. If any holes must be enlarged to admit the rivets, they shall be reamed.

The punching of holes shall be so accurately done that, after assembling the component parts of a member, a cylindrical pin $\frac{1}{8}$ inch smaller than the nominal diameter of the punched holes may be passed through at least 75 of any group of 100 contiguous holes in the same surface or in like proportion for any group of holes. If this requirement is not fulfilled the badly punched pieces shall be rejected. If any holes will not pass a pin $\frac{3}{16}$ inch smaller than the nominal diameter of the punched holes, this shall be cause for rejection.

70.45 Drifting of Holes: The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal.

70.46 Reaming: Material more than $\frac{3}{4}$ " thick shall be sub-punched and reamed or drilled from the solid. Where sub-punching and reaming are required the punch used shall have a diameter not less than $\frac{3}{16}$ inch smaller than the nominal diameter of the rivet. Holes shall then be reamed to a diameter not more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivet.

All reaming shall be done with twist drills and no oil or grease shall be used as a lubricant in reaming.

Reaming shall be done after the pieces forming a built member are assembled and so firmly bolted together that the surfaces are in close contact. The several reamed parts shall be matched-marked, and no interchange of reamed parts will be permitted.

When general reaming is required, or in punched work when specifically required by the Engineer, holes for field connections, except those in lateral, longitudinal and sway bracing, shall be reamed or drilled. Riveted trusses shall be assembled in the shop, the parts adjusted to line and fit, and the holes for field connections reamed or drilled while so assembled. Holes for other field connections shall be reamed or drilled to a metal templet not less than 1 inch thick.

70.47 Burrs: The outside burrs on reamed holes shall be removed.

70.48 Assembling: Riveted members shall have all parts well pinned up and firmly drawn together with bolts before riveting is commenced. All surfaces which

are in contact shall be given a heavy coat of paint, thoroughly and uniformly spread before assembling.

70.49 Eye-Bars: Eye-bars shall be straight and true to size, and shall be free from twists, folds in the neck or head, or any other defect affecting their service strength. Heads shall be made by upsetting, rolling or forging. Welds in the body portions or in the heads of bars will not be permitted. The form of the heads may be determined by the dies in use at the works where the eye-bars are to be made, if satisfactory to the Engineer. The thickness of head and neck shall not overrun more than 1/16 inch.

Boring: Before boring each eye-bar shall be properly annealed and carefully straightened. Pinholes shall be located on the center line of the bar and in the centers of the heads. The holes in the ends of bars shall be bored simultaneously and shall be so accurately located that when the bars of the same truss panels are placed in a pile the pins may be completely inserted in the pin-holes without driving. All eye-bars intended for the same locations in the trusses shall be interchangeable.

70.50 Pins and Rollers: Pins and rollers shall be accurately turned to detailed dimensions and shall be smooth, straight and free from flaws. The final surface shall be produced by a finishing cut.

Forged Pins: Pins having a diameter greater than 6 inches shall be forged and annealed.

Bored Pins: Pins larger than 8 inches in diameter shall have a hole not less than 2 inches in diameter bored longitudinally through their centers. Pins showing defective interior conditions shall be rejected.

70.51 Pin Holes: Pin holes shall be bored true to detailed dimensions, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. A finishing cut shall always be made.

The length outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from detailed dimensions more than 1/32 inch. Boring of holes in built up members shall be done after the riveting is completed.

70.52 Screw Threads: Screw threads shall make close fits in the nuts and shall be U. S. Standard, except that for diameters greater than 1 3/8 inches, they shall be made with 6 threads to the inch.

70.53 Play in Pin Holes: The clearance between any pin and pin hole shall be one-fiftieth (1/50) of an inch up to four (4) inches in diameter, and for larger pins not more than one-thirty-second (1/32) of an inch.

70.54 Forging and Annealing: All forging must be done while the steel is at red heat.

All eye-bars and other forged parts shall be annealed by heating uniformly to the proper temperature followed by slow and uniform cooling in the furnace. The temperature of the bars shall be under full control at all stages.

70.55 Steel Casting: All steel casting shall be annealed.

70.56 Pilot and Driving Nuts: Two pilot nuts and two driving nuts shall be furnished for each size of pin, unless otherwise specified.

70.57 Welds: Welding of steel shall not be permitted except with the approval of the Engineer.

70.58 Riveting and Field Rivets: Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. The heating of the points of rivets more than the remainder will not be permitted. When ready for driving they shall be free from slag, scale and other adhering matter and when driven they shall completely fill the holes. Burned, burred or otherwise defective rivets, or rivets which throw off sparks when taken from the furnace or forge shall not be driven.

Loose, burned, badly formed or otherwise defective rivets shall be cut out. Caulking and recupping of rivet heads will not be allowed. In cutting out defective rivets care shall be taken not to injure the adjacent metal and, if necessary, the rivet shanks shall be removed by drilling.

Countersinking shall be neatly done and countersunk rivets shall completely fill the holes.

Shop rivets shall be driven by direct-acting riveters where practicable. The riveting machine shall retain the pressure for a short time after the unsetting is complete.

Pneumatic hammers shall be used for field riveting except when the use of other hand tools for riveting is permitted by the Engineer.

Field rivets shall be furnished to the amount of 10% plus ten rivets, in excess of nominal number required for each size and length.

70.59 Bolts and Bolted Connections: Bolted connections shall not be used unless specifically authorized. Where bolted connections are permitted the bolts furnished shall be unfinished bolts (ordinary rough or machine bolts) or turned bolts, as specified or directed by the Engineer.

Unfinished Bolts: Unfinished bolts shall be standard bolts with hexagonal heads and nuts. The use of "button head" bolts will not be permitted. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of lengths which will extend entirely through their nuts but not more than $\frac{1}{4}$ inch beyond them. The diameter of the bolt holes shall be $\frac{1}{16}$ inch greater than the diameter of the bolts used.

Turned Bolts: Holes for turned bolts shall be carefully reamed or drilled and the bolts turned to a driving fit by being given a finishing cut. The threads shall be entirely outside of the holes and the heads and nuts shall be hexagonal. Approved nut-locks shall be used on all bolts unless permission to the contrary is secured from the Engineer. When nut-locks are not used, round washers having a thickness of $\frac{1}{8}$ inch shall be placed under the nuts.

70.60 Marking and Shipping: Members weighing more than 3 tons shall have the weight marked thereon. Bolts and rivets of one length and diameter and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and small packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. A

list and description of the contained material shall be plainly marked on the outside of each shipping container.

The weight of all tools and erection material shall be kept separate.

Anchor-bolts, washers, and other anchorage or grillage materials, shall be shipped to suit the requirements of the masonry construction.

70.61 Loading and Unloading: The loading, transportation, unloading and piling of structural material shall be so conducted that the metal will be kept clean and free from injury by rough handling.

ERECTION

70.62 False Work: The Contractor, unless otherwise specified, shall furnish all staging and false work and erect and adjust all metal work. The design of the false work in special cases must be submitted to the Commission for approval if requested.

70.63 Storage: All material shall be stored in such manner as to prevent deterioration by rust or loss of minor parts. No material shall be piled so as to rest upon the ground or in water but must be placed on suitable skids or platforms.

70.64 Preparation of Bearing Area: Column bases, truss and girder pedestals and shoes shall have a full and uniform bearing upon the substructure masonry. Masonry bearing plates shall not be placed upon the bridge seat areas of piers or abutments which are improperly finished, deformed or irregular.

The shoes and pedestals of truss and girder spans, the bases of columns, and the center and end bearings of swing spans shall be rigidly and permanently located to correct alignments and elevations. Unless otherwise provided they shall be placed on a layer of canvas and red lead applied as follows:

Thoroughly swab the top surface of the bridge seat bearing area with red lead paint and place upon it three layers of 12 oz. to 14 oz. duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place in position the superstructure shoes or pedestals while the paint is plastic.

70.65 Handling Members: The field assembling of the component parts of a structure shall involve the use of methods and appliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until its defects are corrected, and members seriously damaged in handling shall be rejected.

70.66 Alignment: Before beginning the field riveting the structure shall be adjusted to correct grade and alignment and the elevations of panel points (ends of floorbeams) properly regulated. For truss spans a slight excess camber will be permitted while the bottom chords are being riveted, but the correct camber and relative elevations of panel points shall be secured before riveting the top chord joints, top lateral system and sway bracing.

70.67 Straightening Bent Material: The straightening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in

which case the heating shall not be to a higher temperature than that producing a dark cherry red color. After heating, the metal shall be cooled as slowly as possible.

Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient or other fractures.

70.68 Assembling and Riveting: All field connections and splices shall be securely drift pinned and bolted before riveting. Important connections in trusses, girders, floor system, etc., shall have at least 50 per cent of the holes filled. An ample number of drift pins shall be used to prevent slipping at joints and splices.

The results obtained in the field assembling and riveting of the members of a structure shall conform to the requirements for shop assembling and riveting. Field driven rivets shall be inspected and accepted before being painted.

Field riveting of tension chord members shall be done before the falsework is removed; but compression chord members shall not be riveted until the span is released sufficiently from the falsework to bring the compression chord joints into full bearing.

Railings shall not be riveted until the falsework has been removed.

70.69 Adjustments of Pin Nuts: All nuts on pins shall be thoroughly tightened and the pins so located in the holes that the members shall take full and even bearing upon them.

70.70 Setting Anchor Bolts: Anchor bolt holes shall be drilled in correct locations vertically to the plane of the bridge seat, and the anchor bolts set in Portland Cement mortar therein. The mortar shall consist of one part cement to one part clean, fine grained sand mixed sufficiently wet to flow freely.

Anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. They shall then be set as follows: Fill the hole about two-thirds full of mortar, and by a uniform even pressure or by light blows with a hammer, (flogging and ramming will not be permitted) force the bolt down until the mortar rises to the top of the hole and the anchor bolt nut rests firmly against the metal shoe or pedestal. Remove all excess mortar which may have flushed out of the hole, to permit proper field painting of the metal surfaces.

The location of the anchor bolts in relation to the slotted holes in expansion shoes shall be varied with the prevailing temperature. The nuts on anchor bolts at the expansion ends of spans shall permit the free movement of the span.

Anchor bolts which are to be set in the masonry prior to the erection of the superstructure shall be carefully set to proper location and elevation with templets or by other suitable means.

70.71 Removal of Debris: Upon completion of the structure, all surplus material, construction buildings and all trees, stumps, etc., that may endanger the structure, also temporary structures and debris resulting from construction, cofferdams, sheeting around piers and abutments, shall be removed and the premises shall be left in a neat, orderly condition. Falsework, timbers and piles are to be removed to the level of the ground. Where work is in a river, such debris shall generally be removed to the bed of the river, or as may be specially directed, and the stream and channel cleared of all debris caused by the Contractor's operation.

No special payment will be made for "Removal of Debris", but the cost shall be covered by prices paid for work.

PAINT

70.72 Red Lead: All red lead shall be pure and shall contain not less than 85% by weight of true Red Lead (Pb304) the balance to be practically pure Lead Monoxide (PbO). It shall not contain more than 1.10% of Metallic Lead and shall be of such fineness that not more than 0.50% remains after washing with water through a No. 12 silk bolting cloth sieve.

70.73 Yellow Ochre: All yellow Ochre shall be pure French Ochre and shall not contain less than 19% of Iron Oxide, nor more than 5% of Lime in any form.

70.74 Sublimed Blue Lead: Shall be free from water soluble sulphates, and from all adulterants. It shall have the following chemical composition.

	Per Cent
Lead Sulphate 40 per cent	55
Lead Oxide 33 per cent	50
Lead Sulphide	8
Lead Sulphate	6
Zinc Oxide	3

70.75 Red Oxide of Iron: Shall contain not less than 65% of oxide of iron (Fe2O3) the remainder being silica and silicates. It may contain sulphur as calcium sulphate not to exceed 0.10%.

70.76 Lampblack: Shall be the fully calcined produce of petroleum products only, free from acids, grit or other adulterants. It shall contain not less than 98% of carbon and not more than 0.5% of oils, tar or pitch.

70.77 Graphite: Shall be the natural graphite and contain not less than 80% of carbon, the remainder being silica, oxides of iron and alumina.

70.78 Asbestine (Magnesium Silicate): Shall be finely ground and free from grit, adulterants or impurities other than silicate of iron, alumina, lime, and manganese.

White Lead: White Lead (Basic Carbonate of Lead) shall approach:

The composition: 2Pb CO3. Pb (OH) 2.

It shall not contain more than a trace of Sulphur Dioxide; not more than 2.50% of Sandy Lead; not more than 0.10% of Organic Matter; not more than 0.10% of Metallic Lead; not more than 0.50% of Lead Sulphate; not more than 0.15% of Acetic Acid.

It shall be of such fineness that not more than 0.50% remains after washing with water through a No. 21 silk bolting cloth sieve.

70.79 Sublimed White Lead (Basic Sulphate of Lead): Shall be amorphous in structure and must not be deficient in density or capacity and shall be free from adulterants. It shall contain not more than 5% of oxide of zinc (ZnO), and not more than 0.75% of sulphur dioxide, not less than 15% lead monoxide (PbO) and the remainder shall be lead sulphate (PbSO4).

70.80 Zinc Oxide: Shall be finely ground and contain not less than 98% of zinc oxide (ZnO) and not more than 2% of grit or adulterants. It shall be free from sulphur dioxide and zinc sulphate.

70.81 Raw Linseed Oil: The Raw Linseed Oil shall conform to the current standard specifications of the American Society for Testing Materials.

70.82 Boiled Linseed Oil: The boiled linseed oil shall conform to the current standard specifications of the American Society for Testing Materials.

70.83 Turpentine: Turpentine shall conform to the current standard specifications of the American Society for Testing Materials.

70.84 Turpentine-Japan Dryer: Turpentine-Japan Dryer shall be of best quality, composed of turpentine and lead or manganese oxides cooked in linseed oil. It shall contain no rosin or naphtha.

70.85 Gum: The gum entering into the composition of hard Gum Varnish shall contain no rosin.

70.86 Raw Tung Oil: The Raw Tung Oil shall conform to the following requirements:

	Maximum	Minimum
Specific Gravity at 15.5°/15.5° C	0.943	0.9400
Acid number (Alcohol-Benzol)	8.0	
Saponification number	195.00	190.00
Unsaponifiable matter, per cent	0.75	
Refractive index at 25 degrees C	1.520	1.5165
Iodine number (wijs)		163
Heating test, minutes	12	

70.87 Pigment for Aluminum Paint: The pigment shall consist of Standard varnish (Albron) aluminum powder as manufactured by the Aluminum Company of America or equal. It shall be flake like in structure and be absolutely free from filter or adulterants such as mica, magnesium silicate, etc. A sample of the powder when tested on standard mesh screens shall show 100% passing through the 100-mesh screen. When suspended in the vehicle, the powder shall form a brilliant apparently continuous metallic layer on the surface of the liquid promptly after stirring is discontinued.

70.88 Vehicle for Aluminum Paint: The vehicle is to be what is commonly known as a "Long oil spar Varnish" which shall fulfill the following requirements: It shall contain not less than 50% by weight of non-volatile oils (vegetable) and gums. It shall be of such consistency that when thoroughly mixed with the aluminum powder in the proportion of two pounds of aluminum powder to one gallon of varnish the finished paint shall show satisfactory spreading qualities and shall not run, sag or curtain when applied to a vertical surface. This consistency will correspond to tubes A to D of the Gardner Holdt Air Bubble Viscosimeter. The varnish shall pass a 60% Kauri reduction test as specified in Federal Board Standard Specification No. 18.

70.89 Time of Setting and Method of Application: The paint shall set to touch in not less than two or more than six hours, and dry hard and tough in not more than twenty-fours.

The aluminum powder shall be packed in bulk and the varnish shall be contained in barrels. The contractor shall equip himself with a reliable, accurate set of scales, graduated to the tenth part of an ounce for proportioning the correct mix. No more paint will be mixed at any one time than can be used on that particular day.

The contractor will not be permitted to apply the aluminum paint by spraying. It must be applied by brushing and care shall be taken that all of the final strokes are made in the same direction in order that particles of powder may "leaf" uniformly in the paint film. The first coat of paint shall be allowed to dry for 48 hours before applying the succeeding coat.

70.90 Manufacture of Lead Paints: The pigments entering into the composition of the paint shall be thoroughly machine ground together in oil and thinned by the addition of oil. For shop coat, turpentine or Japan Dryer shall only be used to the extent specified. The quantity of vehicle specified below shall include the oil used in grinding.

70.91 Terms Used: The terms used in this specification shall have the standard definition adopted by the American Society for Testing Materials. The gallon used in these specifications is the United States gallon, containing 231 cubic inches.

PAINT FOR METAL

70.92 Shop Coat: Paint for the shop coat shall be the following:

Pigment	22 pounds of dry Red Lead
Vehicle	$\frac{3}{4}$ gallon Boiled Linseed Oil
	$\frac{1}{4}$ gallon Raw Linseed Oil

70.93 First Field Coat: Paint for the first field coat shall be the following:

Pigment	22 pounds of dry Red Lead
	2 ounces of Lampblack
Vehicle	$\frac{3}{4}$ gallon Boiled Linseed Oil
	$\frac{1}{4}$ gallon Raw Linseed Oil

70.94 Second Field Coat: Paint for the second field coat will be the following unless otherwise specified:

Pigment	2 pounds Aluminum Powder
Vehicle	1 gallon "Long oil spar varnish"

70.95 Alternate Second Field Coat: Paint for the second coat may be the following:

"A" Pigment	9 pounds of Sublimed White Lead
	3 pounds of Zinc Oxide
	1 ounce of Lampblack
Vehicle	$\frac{3}{4}$ gallon Boiled Linseed Oil
	$\frac{1}{4}$ gallon Raw Linseed Oil

A variation of 5% either way from the quantities of pigment shown by the foregoing formulas will be allowed.

When Red Lead Paste is used it shall be prepared by grinding the lead in the oil in the proportions of 93 pounds of lead to 7 pounds of oil.

The shop coat may be prepared and proportioned as follows:

- 100 pounds of paste (93% Lead) and
- 3.404 gallons oil will make
- 5.528 gallons of paint.
- 18.1 pounds of Paste (93% Lead) and
- .62 gallons of Oil will make
- 1.00 gallons of paint.
- 1 gallon of paint weighs 22.9 pounds.

The first field coat is the same as the Shop Coat with the lampblack added.

70.96 Proprietary Paints: Proprietary Paints may be used when written permission has been obtained from the State Engineer.

The Paint manufacturer shall give guarantee that materials used in making the paint are not inferior to materials here specified.

70.97 No Adulterations: All paint shall be delivered in sealed package or packages bearing the original unbroken bond or label.

TESTING

70.98 Sample of Paint: Before ordering the paint, a sample of at least one quart shall be furnished the department, which sample if approved, will be used in determining the merits of the paints furnished on the work. All paint used must equal the sample in quality.

Samples of paint delivered, at the shop, and in the field, shall be furnished the Department by the Contractor. These samples shall be tested at such laboratory as the Department may direct before any paint is applied.

70.99 Delays: The Contractor should, therefore, secure the necessary paint in ample time so that no delay to the 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.

70.100 Guarantee: In order to prevent the necessary delays in collecting and testing samples, the Contractor may, at the discretion of the Department, submit a certificate of guarantee from the paint manufacturer stating that the paint which the said manufacturer intends to supply for a particular job has been previously tested and accepted by the Department and that the paint to be furnished is guaranteed to conform in every respect to the sample submitted to the Department for testing.

PAINTING STEEL STRUCTURES

70.101 General Conditions: The painting of metal structures shall include, unless otherwise provided in the contract, the proper preparation of the metal surfaces, the application, protection and drying of the paint coatings, the protection of pedestrian, vehicular or other traffic upon or underneath the bridge structure, the pro-

tection of all portions of the structure (superstructure and substructure) against disfigurement by spatters, splashes and smirches of paint or of paint materials, and the supplying of all tools, tackle, scaffolding, labor, workmanship and materials necessary for the entire work.

70.102 Cleaning: Cleaning shall be thoroughly done. All rust, mill-scale, dirt, oil and grease, mortar or other foreign material shall be removed leaving a perfectly clean surface to receive the paint. After the cleaning operation has been completed, all rust, dust, etc., must be wiped off clean with cloths or cotton waste or dusted off with a stiff bristle brush from all metal surfaces, crevices, cracks or joints.

70.103 Painting Conditions: Painting shall be done only when the metal is free from frost and the surface is perfectly dry.

No painting shall be done in wet or freezing weather, except under cover, in a building so enclosed that the metal may be kept dry and the temperature above freezing. Material painted under cover shall be kept under cover until dry. All paint must be thoroughly dry before any succeeding coat of paint is applied.

70.104 No Adulteration: The paint must not be different from the original state when contained in the unbroken package or barrel and must not be mixed with any other material, nor shall it be thinner than what is found in the original barrel or package; it must be free of paint skins, dirt or foreign matter accumulating while in course of application, which, when happening, must be removed by straining.

70.105 Stirring the Paint: The paint shall be thoroughly stirred up from the bottom with paddles at least three inches wide at the bottom, so that no sediment remains, and the paint continually stirred up and mixed during the progress of its application, so that it will attain a uniform consistency until the work is completed.

70.106 Application: No wide, flat brushes shall be used. All brushes shall be either round or oval in shape.

The paint when applied shall be so manipulated under the brush as to produce a uniform even coating in close contact with the metal or with previously applied paint. In general, the primary movement of the brush shall describe a series of small circles to thoroughly fill all irregularities in the surface, after which the coating shall be smoothed and thinned by a series of parallel strokes.

To secure a maximum thickness of paint film upon rivet heads, and edges of plates, angles or other rolled shapes these areas shall be "stripped" in advance of the general painting, and shortly afterward shall be given a second or "wash" coat when the general coat is applied. The paint shall be well worked into all joints and open spaces.

All painting must be done in a neat and workmanlike manner.

On all surfaces which are inaccessible for paint brushes, the paint shall be applied with sheep skin daubers specially constructed for the purpose.

No two succeeding coats of paint shall be of the same tint. The Contractor shall add an additional amount of chrome yellow to paints that are nearly the same color.

70.107 Removal of Improper Paint: All metal coated with impure or unauthorized paint shall be thoroughly cleaned and repainted to the satisfaction of the Engineer, at the expense of the Contractor.

70.108 Thinning: If it is necessary in cool weather to thin the paint in order that it shall spread more freely, this shall be done only by heating in hot water or on steam radiators.

70.109 Number of Coats: All steel shall have one shop coat of Red Lead Paint and after erection, two field coats of paint as specified. The exception to this rule may be that hand rails and cover plates of end posts may be given two field coats of aluminum paint or white lead and oil when specifically ordered.

70.110 Shop Painting: In riveted work, all surfaces coming in contact shall be painted before being assembled. This means lattice bars, connection angles, tie and batten plates, gusset plates, etc. All pieces and parts not accessible for painting after erection, including tops of stringers, eyebar heads, posts and chords, etc., shall receive an additional coat, of the last field coat. All erection and shop marks shall be painted on painted surfaces.

70.111 Machine Finished Surfaces: With the exception of abutting chord and column splices, column and truss shoe bases, machine finished surfaces shall be coated as soon as practicable after being accepted and before being put in the open with a hot mixture of white lead and tallow. Surfaces of iron and steel castings milled for the purpose of removing scales, scabs, fins, blisters or other surface deformations shall generally be given the shop coat of paint.

The composition used for coating machine finished surfaces shall be mixed in the following proportions:

4 lbs. pure tallow
2 lbs. pure white lead
1 qt. pure linseed oil

70.112 First Field Coat: While the metal work is being erected in place, all abrasions of the shop paint and all field rivets and bolts and location marks shall be thoroughly cleaned and be given one coat of the shop paint specified preparatory to the first field coat. After the structure is complete in place and the "Touching Up" described above is thoroughly dry, it shall be given a complete coat of one of the paints as specified.

70.113 Second Field Coat: After the first field coat is thoroughly dry the second field coat shall be applied. The second coat shall be a different color from the first coat.

70.114 Maintenance Painting: Unless otherwise provided maintenance painting shall consist of the removal of the rust, scale, dead paint, dirt, grease or other foreign matter from the metal parts or portions of existing bridge structures and the application of paint thereto.

All metal surfaces not in close contact with other metal surfaces or with wooden floor or truss members, concrete, stone masonry, etc., shall be considered as exposed to deterioration by rusting and shall be thoroughly cleaned and painted the number of coats indicated in and made a part of the contract.

Unless otherwise provided, metal after being cleaned to the satisfaction of the Engineer shall be painted at least two coats of paint.

The requirements and methods of procedure for maintenance cleaning and painting shall be the same as specified for shop and field painting.

Whenever roadway or sidewalk planking is laid too closely in contact with the metal to permit free access for proper cleaning and painting, the planks shall either be removed or shall be cut to provide at least a one inch clearance for that purpose. The removal or the cutting of planks shall be done as directed by the Engineer. All planks removed shall be satisfactorily replaced and if broken or otherwise injured to an extent rendering them unfit for use they shall be renewed at the expense of the Contractor.

70.115 Bolts: Bolts which are to pass through non-resinous wood shall receive two coats of the paint specified which shall be allowed to become perfectly dry before the bolts are used.

70.116 Basis of Payment: Unless otherwise specified the paint shall be furnished and applied by the Contractor for structural steel, and will be included in the contract unit price or lump sum for structural steel, complete in place, which will include the cost of all material and labor entering into the operation.

DESIGN AND DETAILS OF STEEL STRUCTURES

LOADING

70.117 Dead Loading: Detailed plans submitted under these specifications shall provide for the following loadings:

The dead loading includes the weight of the structure, floor and fill, using the following unit weights:

Steel Sections as given in hand books:

Stone	160 pounds per cu. ft.
Reinforced Concrete	150 pounds per cu. ft.
Brick	150 pounds per cu. ft.
Asphalt	150 pounds per cu. ft.
Gravel	140 pounds per cu. ft.
Macadam	140 pounds per cu. ft.
Earth Filling	100 pounds per cu. ft.
Timber, Pine and Fir	4 pounds per ft. B. M.
Oak	5 pounds per ft. B. M.
Creosoted Lumber	5 pounds per ft. B. M.

The dead load used in figuring stresses must not vary more than 5 per cent from the actual estimated weight for the completed design.

LIVE LOAD

70.118 Highway Loads for Bridge Floors: The integral parts of bridge floor systems, including their direct connections to trusses, girders and viaduct towers and bents, shall be designed for the maximum stresses produced by truck concentrations. Floorbeam hangers and all integral members or parts of trusses and girders

subjected to the direct action of floor loads and impacts shall correspondingly be designed for truck concentrations. The truck dimensions and weight distributions used for design purposes shall be those of the typical or standard truck shown in Figure II. This standard truck is designated by the letter "H", followed by a numeral indicating its gross or total weight in tons.

The class of loading used shall be the following:

Loading H15. 15-ton trucks.

Highway Loads for Trusses and Girders: The trusses and girders of bridge spans and the columns of viaduct towers and bents shall be designed for the stresses produced by a load on each traffic lane composed of a uniform load per linear foot of lane with a concentrated load so located longitudinally therein as to produce maximum stresses. The concentrated load shall be considered as uniformly distributed transversely on a line having a length equal to the width of the lane. The standard truck clearance width of 9 feet shall be assumed as constituting the width of one traffic lane.

The class of loading used shall be the following:

Loading H15. A total load on each traffic lane composed of a uniform load of 450 lbs. per linear foot and a single concentrated load of 21,000 lbs.

70.119 Application of Loads to Girders and Trusses: Trusses and girders shall be designed to support as many traffic lanes as the width of roadway will permit, assuming them to be placed symmetrically with regard to the roadway center line.

To provide for an increase in truss and girder stresses resulting from the passage of eccentrically placed loads and for a decrease in traffic lane intensity for increasing widths of roadway, the stresses obtained by the application of the above loading shall be multiplied by the coefficient "C" given by the following formula:

$$C = \frac{18 + W}{18n}$$

Where W = the width of roadway for bridges with two main girders or trusses; or the distance center to center of girders or trusses for bridges with more than two main girders or trusses.

n = number of lanes of traffic.

70.120 Application of Loads to Floor System: Bridge floor systems shall be designed to support as many trucks, not exceeding four, as the width of roadway will permit.

When the design of the floor system involves the placing of trucks adjacent to curbs, the extreme position of a truck shall be assumed as that in which the center of the outside wheel is 1'-6" from the inside edge of the curb.

In the design of floorbeams and their supports the following percentages of the resultant live load stresses shall be used:

	Per Cent
One or two trucks.....	100
Three trucks	90
Four trucks	80

Sidewalk Loads: All sidewalk stringers and brackets shall be designed to support a live load of not less than 100 pounds per square foot of sidewalk area.

Girders or trusses supporting sidewalks shall be designed to support a sidewalk live load as determined by the following formula, provided that in no case shall the live load be less than 20 pounds per square foot of sidewalk area:

$$P = (80 - 0.125L) (1 - 0.025W)$$

where P = live load in pounds per square foot of sidewalk area.

L = loaded length of sidewalk in feet.

W = clear width of sidewalk in feet.

No impact increment shall be added to sidewalk load.

In general, provision shall be made to prevent the encroachment of roadway loads upon the sidewalk area. Whenever the details of the structure permit such encroachment, the sidewalks shall be designed for the roadway loads and impacts so involved.

70.121 Distribution of Wheel Loads in Concrete Slabs: In calculating bending stresses due to wheel loads on concrete slabs, no distribution in the direction of the span of the slab shall be assumed. In the direction perpendicular to the span of the slab, the wheel load shall be considered as distributed uniformly over a width of slab which is known as the "effective width".

In the following equations let

S = span of slab in feet

W = width of wheel or tire in feet

X = distance in feet from the center of the near support to the center of wheel

E = effective width in feet for one wheel

Case I. Main Reinforcement Parallel to Direction of Traffic.

$$E = 0.7 S + W$$

For this case the value of "E" shall not exceed 7 feet.

When two wheels are so located on a transverse element of the slab that their effective widths overlap, the effective width for each wheel shall be $\frac{1}{2} (E + a)$, where "a" is the distance between centers of wheels.

Case II. Main Reinforcement Perpendicular to Direction of Traffic.

$$E = 0.7 (2x + W)$$

For this case the bending moment on a strip of slab one foot in width shall be determined by placing the wheel loads in the position to produce maximum bending; determining the effective width for each wheel; and assuming the load delivered by each wheel to the one foot strip to be the wheel load divided by its respective effective width.

This design assumption does not provide for the effect of loads near unsupported edges. Therefore, at the ends of the bridge and at intermediate points where the continuity of the slab is broken, the edges of the slab shall be supported by diaphragms or other suitable means.

70.122 Distribution of Wheel Loads in Longitudinal Beams or Stringers and in Transverse Floorbeams: Shear. In calculating end shears and end reactions in

transverse floorbeams and longitudinal beams or stringers, no lateral or longitudinal distribution of the wheel loads shall be assumed.

Bending Moment in Longitudinal Beams or Stringers. In determining bending moments in longitudinal beams or stringers, no longitudinal distribution of the wheel loads shall be assumed. The lateral distribution may be determined in one of the following ways:

(a) **Absolute Method.** For designs in which extreme accuracy is desired, the lateral distribution may be very closely determined by considering the flooring as continuous over a series of elastic supports and forming upon this hypothesis a series of work equations.

(b) **Approximate Method.** For ordinary construction the lateral distribution may be determined by the following approximate method:

Let M = one-half the bending moment produced by one truck.

S = spacing of beams in feet.

M_1 = bending moment in one interior beam which is not subject to loads from passing trucks.

M_2 = bending moment in one interior beam which is subject to loads from passing trucks.

$$M_1 = \frac{MS}{4} \text{ for plank floors.}$$

$$M_1 = \frac{MS}{4.5} \text{ for strip floors 4 inches in thickness and for wood blocks on a 4-inch plank sub-floor.}$$

$$M_1 = \frac{MS}{5.5} \text{ for strip floors 6 inches or more in thickness.}$$

$$M_1 = \frac{MS}{6} \text{ for reinforced concrete floors.}$$

$$M_2 = 1.2 M_1 \text{ for the type of floor involved.}$$

When the stringer spacing is such " M_1 " or " M_2 ", as the case may be, exceeds " M ", the stringer loads shall be determined by the reactions of the truck wheels, assuming the flooring between stringers to act as simple beams.

(c) **Outside Stringers.** The live load supported by the outside stringer shall be the reaction of the truck wheels, assuming the flooring to act as a simple beam, but this live load shall in no case be less than would be required for interior stringers under the requirements specified above.

(d) **Total Capacity of Stringers.** The combined load capacity of the beams in a panel shall not be less than the total live and dead load in the panel.

70.123 Bending Moment in Floorbeams: In determining bending moments in transverse floorbeams, no transverse distribution of the wheel loads shall be assumed.

When longitudinal stringers are omitted and the floor is supported directly on the floorbeams, the longitudinal distribution shall be determined as follows:

Let M = total maximum bending moment due to the superimposed rear axle loads.

S = longitudinal spacing of floorbeams in feet.

M_1 = bending moment in one floorbeam.

$$M_1 = \frac{MS}{4} \text{ for plank floors.}$$

$$M_1 = \frac{MS}{4.5} \text{ for strip floors 4 inches in thickness and for wood blocks on a 4 inch plank sub-floor.}$$

$$M_1 = \frac{MS}{5.5} \text{ for strip floors 6 inches or more in thickness.}$$

$$M_1 = \frac{MS}{6} \text{ for reinforced concrete floors.}$$

When the floorbeam spacing is such that " M_1 ", as given by the above equations, exceeds " M ", the floorbeam loads shall be determined by the reactions of the truck wheels, assuming the flooring between floorbeams to act as simple beams.

70.124 Wind Loads: The top lateral bracing in the deck bridges and the bottom lateral bracing in through bridges shall be designed to resist a lateral wind load of 300 pounds per lineal foot and one-half of this shall be treated as a moving load. The bottom lateral bracing in deck bridges and top lateral bracing of through bridges shall be designed to resist a lateral wind load of 150 pounds per lineal foot.

70.125 Impact: All live load stresses, except those due to sidewalk loads and centrifugal, tractive and wind forces, shall be increased by an allowance for dynamic, vibratory and impact effects.

For end floorbeams the impact allowance shall be 60% of the live load stress.

For all other portions of structures, the impact allowance or increment is expressed as a coefficient of the live load stress varying with the loaded length of the structure and the width of the roadway area. Its intensity is determined by the following formulas in which

I = impact coefficient.

L = loaded length of span in feet producing the maximum static stress in the member considered.

W = the width of roadway for bridges with two main girders or trusses; or the distance center to center of girders or trusses for bridges with more than two main girders or trusses.

$$I = \frac{36}{W + 18} \frac{(L + 250)}{(10L + 500)}$$

For highway loads, the maximum value of " I ", as given by the above formulas, shall not exceed 0.30.

70.126 Proportioning: All parts of the bridge shall be proportioned for the dead load, live load and impact stresses, using the unit stresses as designated in these specifications. The computed dead, live and impact stresses shall be indicated sepa-

rately. The dead loads and assumed live loads used for the design of each structure shall be shown on the drawing or stress sheet.

UNIT STRESSES

70.127 General: Except as otherwise provided herein, the several parts of a structure shall be so proportioned that the unit stresses will not exceed the following. Unless otherwise noted, all unit stresses are given in pounds per square inch.

STEEL STRUCTURES

70.128 Structural Grade and Rivet Steel: Tension.

Axial tension, structural members, net section.....	16,000
Rivets in tension, where permitted, 50% of single shear values.	
Bolts, area at root of thread.....	10,000

Axial Compression.

Axial compression, gross section.....	15,000-50 L/r
But not to exceed 13,500.	
L = length of member, in inches.	
r = least radius of gyration, in inches.	

Bending on Extreme Fiber.

Rolled shapes, built sections and girders, net section.....	16,000
Pins	24,000

Shear.

Girder webs, gross section	10,000
Pins and shop driven rivets	12,000
Power driven field rivets and turned bolts	10,000
Hand driven rivets and unfinished bolts	7,500
Shop and field rivets and turned bolts in floor system.....	8,000

Bearing.

Pins, steel parts in contact and shop driven rivets	24,000
Power driven field rivets and turned bolts	20,000
Hand driven rivets and unfinished bolts	15,000
Expansion rollers, pounds per linear inch	600d
Where d = diameter of roller in inches.	
Shop and field rivets and turned bolts in floor system	16,000

Countersunk Rivets.

In metal $\frac{3}{8}$ inch thick and over, half the depth of countersink shall be omitted in calculating bearing area.
 In metal less than $\frac{3}{8}$ inch thick, countersunk rivets shall not be assumed to carry stress.

Diagonal Tension.

In webs of girders and rolled beams, at sections where maximum shear and bending occur simultaneously	16,000
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70.129 Other Metal: Axial Tension.

Wrought-iron	12,000
Bending on Extreme Fiber.	
Cast steel	12,000
Cast iron	3,000
Shear.	
Cast steel	10,000
Cast iron	3,000
Bearing.	
Cast steel	14,000
Cast iron	10,000
Bronze sliding expansion bearings	3,000

70.130 Wind Stress: For stresses in girder flanges, truss members or trestle columns due to wind pressure combined with those from dead load, live load and impact, the unit stresses given in the table may be increased 25 per cent but the section shall not be less than required for dead load, live load and impact. When lateral forces along or in combination with other forces can neutralize or reverse the stress in any member, it shall be proportioned in accordance with the requirements for alternate stresses.

70.131 Secondary Stresses: Members and their details shall be proportioned to reduce secondary stresses to a minimum. In simple trusses without subdivided panels the secondary stresses due to deformation in any member whose width measured in the plane of flexure is less than one-tenth of its length need not be considered. When this ratio is exceeded, or where subdivided panels are used, the secondary stresses shall be computed.

In members designed for secondary stresses in combination with other stresses the specified allowable unit stresses may be increased 30% but the sections shall not be less than required for primary stresses.

GOVERNING DIMENSIONS

70.132 Spacing of Trusses and Girders: Main trusses and girders shall be spaced a sufficient distance apart center to center, to be secure against overturning by the assumed lateral and other forces.

70.133 Dimensions for Stress Calculation: Effective Span. For the calculation of stresses, span lengths shall be assumed as follows:

- Beams and girders, distance between centers of bearings.
- Trusses, distance between centers of end pins or of bearings.
- Floorbeams, distance between centers of trusses or girders.
- Stringers, distance between centers of floorbeams.

Effective Depth. For the calculation of stresses, effective depths shall be assumed as follows:

- Riveted trusses, distance between centers of gravity of the chords.
- Pin-connected trusses, distance between centers of chord pins.

Plate girders, distance between centers of gravity of the flanges but not to exceed the distance back to back of flange angles.

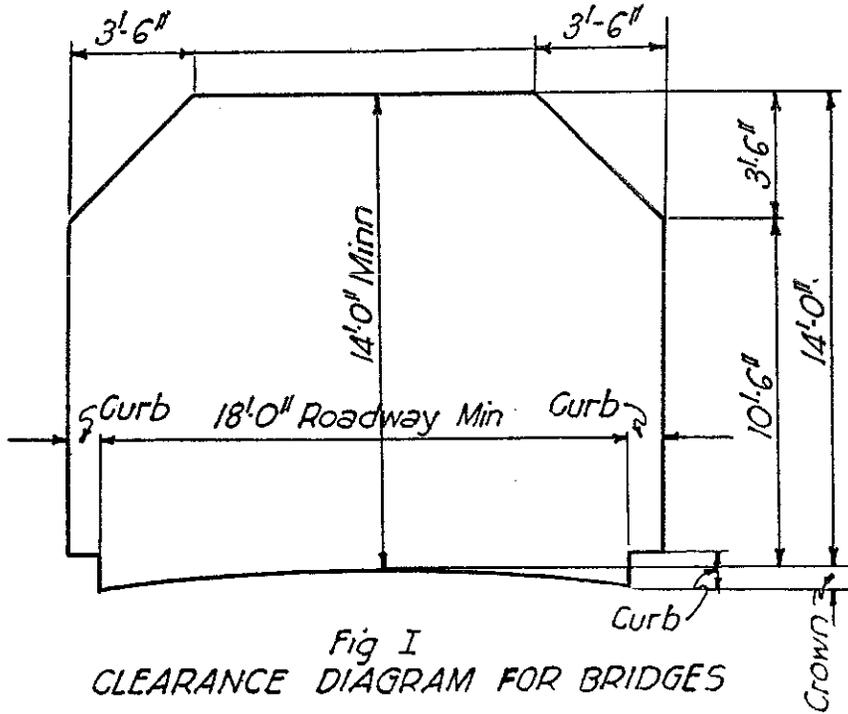


Fig. I
CLEARANCE DIAGRAM FOR BRIDGES

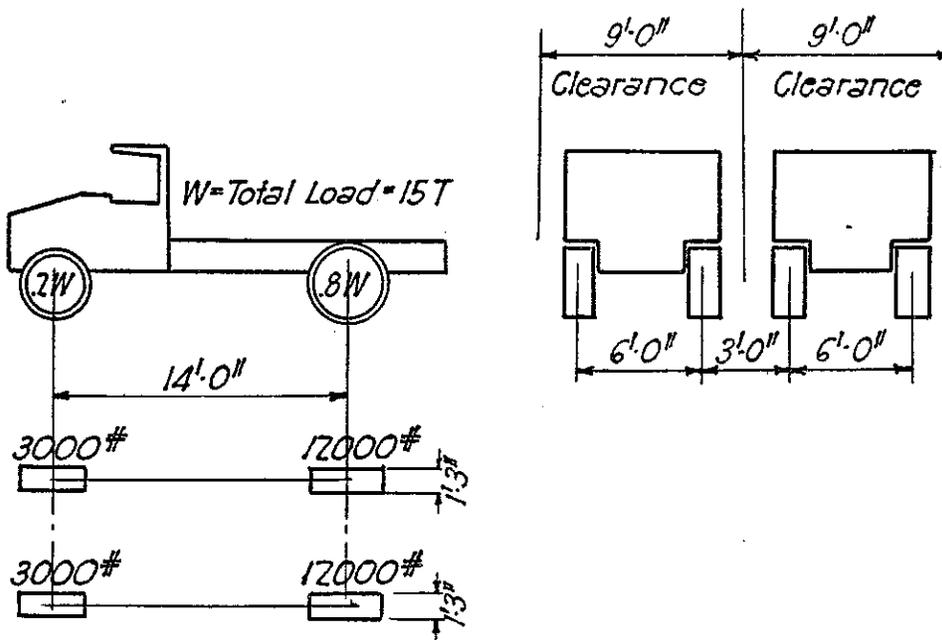


Fig. II
STANDARD TRUCK

70.134 Working Lines: In general the following working lines shall be used:

For channels with cover plates used for top chords and end posts, working lines shall be taken as near as practicable to the center of gravity of the section. For two angle chord and diagonal sections the working line may be taken as the gage line nearest the back of the angle. For symmetrical sections the working line shall be taken as center of gravity of the section.

70.135 In general, the gravity axis of main truss and other important members, meeting to form a joint, shall intersect in a common point so as to avoid eccentricity of stress. In cases of unavoidable eccentricity the members affected thereby shall be proportioned and the connection details designed to resist the stresses produced.

70.136 Depth Ratios: The ratio of depth to span shall not be less than the following:

For rolled beams	1-30
For plate girders	1-12
For riveted trusses	1-10
For pin connected trusses	1-10

70.137 Clearance: The clear width of roadway shall not be less than eighteen (18) feet. See diagram Figure No. I.

70.138 Waterway: The waterway shall be adequate for the passage of ordinary flood water and drift at a velocity not exceeding the average velocity of the stream in the vicinity of the bridge, and shall be adequate for the passage of extreme flood water known, unless other provisions are made for same. By ordinary flood water is meant the stage that is likely to occur once in ten years.

70.139 Reversal of Stress: Members subject to reversal of stress during the passage of live load shall be proportioned as follows: Determine the tensile and compressive stresses and increase each by 50% of the smaller; then proportion the member so that it will be capable of resisting each increased stress. The connections shall be proportioned for the sum of the actual stresses.

70.140 Combined Stresses: Members subject to both axial and bending stresses shall be proportioned so that the combined fiber stresses will not exceed the allowed axial stress.

70.141 Counters: Whenever the live and dead load stresses are of opposite character only two-thirds (2/3) of the dead load stress shall be considered as effective in counteracting the live load stress.

Rigid counters are preferred, and where subject to reversal of stress shall preferably have riveted connections to the chords. Adjustable counters shall have open turn-buckles. Only one diagonal in a panel of a truss shall be adjustable.

70.142 Floor Framing: Steel joists shall preferably be riveted to the web of floor beams. Floor beams shall be arranged perpendicular to the girders or trusses at the panel points and in through bridges shall be riveted to the verticals. Rolled shapes as floor beams and joists shall be proportioned as required for maximum loads specified.

70.143 Through Truss Spans: Through truss spans shall be deep enough to permit the construction of adequate rigid portals, and the end posts shall be proportioned to resist the bending stress produced, by that part of the wind load delivered by the top lateral system. Sway bracing, or struts with knee braces, as deep as the required clearance will allow, shall be provided at all intermediate panel points sufficiently strong to carry one-half of the top chord wind load to the plane of the bottom chord, and intermediate posts shall be designed to resist bending thus produced.

All members of the web, lateral, longitudinal or sway bracing must be securely fastened at their intersections to prevent sagging and rattling.

70.144 Plate Girders: If desired, plate girder spans over 50 feet in length shall be built with camber at a rate of 1/16 inch per 10 feet of length.

70.145 Camber: Trusses carrying concrete floors shall be cambered by making the top chord or its horizontal projection longer than the bottom chord by 3/16 inch to every 10 feet for trusses up to 250'-0" long. For longer trusses the deformation of the individual members shall be calculated for dead load, one-half live load and impact and the members adjusted in length the amount of the deformation.

70.146 Indirect Splices: In all splice plates not in direct contact with the parts they connect, the number of rivets on each side of the joint shall be in excess of the number which would otherwise be required for a contact splice to the extent of two extra transverse lines for each intervening plate.

70.147 Minimum Thickness of Metal: No material shall be used less than 1/4 inch in thickness except for lining or filling vacant spaces and in webs or rolled channels where 21/100 inch shall be the minimum.

Minimum thickness of metal in castings shall be 3/4 inch except for filler blocks.

70.148 Minimum Sections: The minimum size of the angle shall be 3 x 2 1/2 x 1/4 inches, except in fences or latticing, in which case 1 1/2 x 1 1/2 x 1/4 inch angles are the minimum which may be used.

Rods if used shall have a minimum net section of 55/100 of one square inch and upset rods a minimum net section of 75/100 of one square inch.

70.149 Designs and details shall be so arranged that all parts will be accessible for inspection, cleaning, painting and repair and shall shed water and not retain dirt, dust, leaves, or other foreign matter. Wherever angles are used either singly or in pairs, they shall be placed with vertical legs extending downward.

70.150 Pockets: Pockets or depressions which would hold water shall have drain holes, or be filled with waterproof materials.

70.151 Expansion and Contraction: Provision shall be made for all bridge structures to change in length, owing to temperature changes, at least one-eighth (1/8) inch for each ten (10) feet of span, and joints shall be provided at such points in the floor and pavement, and hand rail as may be indicated on the shop drawings.

70.152 Expansion Bearings: Spans of less than 70 feet may be arranged to slide upon metal plates with smooth surfaces. Spans of 70 feet and over shall be provided with rollers or rockers, or with the special sliding bearings described below. Neither rollers nor rockers shall be used for expansion bearings at the top of trestle posts.

70.153 Fixed Bearings: Fixed bearings shall be firmly anchored.

70.154 Hinged or Pin Bearings: Spans of 70 feet and over shall have hinged pin bearings at both ends. The pedestals or shoe shall be so designed that all loads will act through the end pins which will be located directly over the geometrical center of the bearing.

70.155 Rollers: Expansion rollers shall not be less than 4 inches in diameter for span lengths of 100 feet or less and this minimum shall be increased not less than 1 inch for each additional 100 feet of span, and proportionally for intermediate lengths. They shall be connected together by substantial side bars and shall be effectually guided so as to prevent lateral movement, skewing or creeping. The rollers and bearing plates shall be protected from dirt and water as far as possible and the construction shall be such that water will not be retained and that the roller nests may be inspected and cleaned with the minimum difficulty.

70.156 Rockers: Pin bearing expansion rockers shall be of cast steel or cast iron.

70.157 Special Sliding Expansion Bearings: Sliding plates for the expansion bearings of spans of 70 feet and over shall be of bronze conforming to the requirements of Items 70.24 and 70.25. These plates shall be chamfered at the ends and shall be held securely in position, usually by being inset into the metal of the pedestals and sole plates. Provision shall be made against any accumulation of dirt which will obstruct their free movement.

70.158 Pedestals and Shoes: Pedestals and shoes shall be designed to secure rigidity and stability and to distribute the reaction uniformly over the entire bearing area. Preferably, they shall be made of cast steel or structural steel. The bottom bearing widths shall not exceed the top bearing widths by more than twice the depth of pedestal and, when involving pin bearings, this depth shall be measured from the center of pin.

Where built pedestals and shoes are used, the web-plates and the angles connecting them to the base plates shall be not less than $\frac{1}{2}$ inch thick. If the size of the pedestal permits, the webs shall be rigidly connected transversely.

70.159 Sole Plates: Expansion sole plates shall be planed true and smooth. The finishing out of the planing tool shall be fine, and correspond with the direction of expansion. Sole plates must have a true and uniform bearing on the bridge seats and if necessary shall be set on sheet lead, molten lead, babbitt or sulphur. Sole plates shall not be less than $\frac{3}{4}$ " thick.

70.160 Inclined Bearings: Bridges on a grade without pin shoes shall have the sole plates beveled so that the masonry and expansion surfaces may be level.

70.161 Anchor Bolts: The setting of all anchor bolts for the steel work shall be included as part of the contract for the superstructure. The size of anchor bolts shall be as follows:

For spans less than 50 feet in length, 2 bolts, one inch in diameter, set 10 inches in masonry.

Span 50 to 100 feet, 2 bolts, $1\frac{1}{4}$ inches in diameter, set 12 inches in masonry.

Span 100 to 150 feet, 2 bolts, $1\frac{1}{2}$ inches in diameter, set 15 inches in masonry.

Span 150 to 200 feet, 4 bolts, $1\frac{1}{2}$ inches in diameter, set 18 inches in masonry.

Where continuous bearing plates are used over piers, 4 bolts of the size above specified shall be used.

70.162 Anchorage: Anchor bolts for viaduct towers and similar structures shall be long enough to engage a mass of masonry the weight of which is at least one and one-half times the uplift.

TENSION MEMBERS

70.153 Stiffness Requirement: For main riveted tension members the ratio of length to least radius of gyration shall not exceed 200.

70.154 Tension Members: Net sections must be used in all cases in calculating tension members, deducting the area of rivet holes one-eighth ($\frac{1}{8}$) inch in diameter larger than the nominal size of the rivet. The net sections at pin holes shall be twenty-five (25) per cent in excess of the net section through the body of the main member. The net section back of the pin hole, parallel to the axis of the members shall not be less than through the body of the main member and there shall be sufficient rivets to make the material effective.

The net section shall be the least area which can be obtained by deducting from the gross sectional area, the area of holes cut by any straight or zig-zag section across the member, counting the full area of the first hole and a fractional part of each succeeding hole, the fractional part being determined by the formula:

$$X = 1 - \frac{S^2}{4gh}$$

Where X = fraction of rivet hole to be deducted.

S = stagger or longitudinal spacing of rivet with respect to rivet on last gage line.

g = distance between gage lines, or transverse spacing.

h = nominal diameter of rivet plus $\frac{1}{8}$ inch.

70.165 Connections: The strength of connections shall be sufficient to develop the full strength of the members, even though the computed stress is less.

When but one leg of a single angle section is riveted to its connection, the net section of that leg plus 50% of the area of the unconnected leg will be considered as effective in tension.

The effective area of a double angle tension member shall be assumed as 80% of the net area of the member unless the end details and connections are such that the individual angles are held against bending in both directions, in which case the full net area may be used. When the angles connect to separate gusset plates, as in the case of a double-webbed truss, the gusset plates shall be stiffened by diaphragms in the line of the connected angles or by tie plates extending to the ends of the angles if they are to be considered as offering such resistance to bending that the full net area can be used. When the angles are connected back to back on opposite sides of a single gusset plate the support may be assumed to be sufficient to allow the use of the full net section.

Lug angles shall not be considered as effective in transmitting stress.

70.166 All splices of members in tension composed of angles must have both legs connected with splice plates. Splices must develop the full net section.

70.167 Tie Plates: All built up tension members shall have tie plates spaced not over 3'0" center to center. The end tie plate shall be as near the ends as possible and have a length equal at least to the width of the members, the intermediate tie plate to be not less than 7½ inches in length. All plates shall have a thickness not less than 1/50 of the distance between rivet lines. The rivets shall preferably be spaced at the minimum distance allowed for the size used.

70.168 Splices in Lower Chord: In spans 100 feet and over, splices in lower chord of riveted bridges shall be made outside the gusset plates.

70.169 Diaphragms: At all points where floor beams, portals, or other bracing with the posts or chords, proper diaphragms must be inserted to distribute the loads and forces over the full section of these posts or chords.

COMPRESSION MEMBERS

70.170 Limiting Lengths of Members: Compression Members. The ratio of unsupported length to the least radius of gyration shall not exceed 120 for main compression and stiffening members. In proportioning the top chords of low trusses the unsupported length shall be assumed as the length between the rigid verticals.

70.171 Compression Members: In built up compression members the metal shall be concentrated as much as possible in the webs and flanges, so that the center of gravity of the section may be as near the center line of the member as practicable.

70.172 Plates in Compression: Cover plates of built up compression members and cover plates on the compression flanges of plate girders shall have a minimum thickness of 1/40, and the web plates of compression members a minimum of 1/30, of the transverse distance between the lines of rivets connecting them to the flanges. However, failing to meet this requirement, the width of plate between the connecting lines of rivets in excess of 40 times the thickness for cover plates and 30 times the thickness for web plates, shall not be considered as effective in resisting stress.

70.173 Outstanding Flanges: Outstanding compression flanges of girders and main compression members shall have a minimum thickness of $1/12$ of the width of outstanding flange. For lateral bracing and other secondary members this minimum thickness may be $1/14$ of the width of the outstanding flange.

70.174 Tie Plates: The open sides of compression members shall be provided with lattice, and shall have tie plates as near each end as practicable. Tie plates shall be provided at intermediate points where the lattice is interrupted. In main members, the end tie plates shall have a length not less than the width of the member on the connected side, and intermediate ones a length of not less than three-fourths ($3/4$) this distance. Their thickness shall not be less than one-fiftieth ($1/50$) of the same distance. The minimum thickness shall not be less than one-fourth ($1/4$) inch.

For lateral struts and other secondary members, the length of end and intermediate tie plates shall be not less than $3/4$ the perpendicular distance between the lines of rivets connecting them to the member.

70.175 Lacing Bars: The lacing of compression members shall be proportioned to resist a transverse shear not less than that calculated by the formula.

$$S = 300 A$$

Where S = transverse shear in pounds.

A = gross area of member in square inches.

This shear shall be considered as divided equally among all stiffening parts in parallel planes, whether made up of continuous plates or of lattice. The stress in the individual lacing bar shall be taken as the component of the shear, in the direction of the bar, in case single lacing is used and half that amount if double lacing is used. The size of the bar shall be determined by the column formula in which " L " shall be taken as the distance between the connections to the main sections.

The minimum width of lacing bars shall be:

For $7/8$ inch diameter rivets $2\frac{1}{2}$ inches

For $3/4$ inch diameter rivets $2\frac{1}{4}$ inches

For $5/8$ inch diameter rivets 2 inches

Lacing bars having two rivets in each end shall be used for flanges 5 inches or more in width.

The minimum thickness of bars shall be $1/40$ of the distance between end rivets in the case of single lacing and $1/60$ of this distance for double lacing.

Double lacing, riveted at the intersections, shall be used when the perpendicular distance between rivet lines exceeds 15 inches.

The inclination of single lacing shall generally be about sixty degrees and for double lacing it shall be about forty-five degrees to the axis of the member. Furthermore, the maximum spacing of lacing bars shall be such that the ratio of length to radius of gyration (L/r) for the portion of single flange between consecutive connections will be smaller than this ratio for the member as a whole.

Shapes of equivalent strength may be used instead of flats.

70.176 Forked Ends: Forked ends on compression members will be permitted only when unavoidable. When used, a sufficient number of pin plates shall be provided to give each jaw the full strength of the compression member. At least one pair of these plates shall extend to the far edge of the tie plates, and the others not less than 6 inches beyond the near edge of the tie plates.

70.177 Rivet Spacing in Compression Members: The pitch of rivets at the ends of built compression members shall not exceed the minimum pitch for a length equal to one and one-half times the maximum width of the member. Beyond this point the rivet pitch may be gradually increased for a length equal to one and one-half times the maximum width of the member until the maximum spacing is reached.

70.178 Splices and Connections: The splices in compression members shall be located as near the panel point as practicable. In all cases, the splices or connections shall develop the full strength of the member, even though the computed stress is less. No allowance shall be made for milled joints.

Where splice plates or connecting angles are separated by fillers, the number of rivets on each side of the point shall be increased by 33 1/3 per cent of the number theoretically required for each intervening plate.

70.179 A diaphragm shall be provided between gusset plates engaging main members whenever the end tie plate is located at a distance of 4 feet or more from the point of intersection of the members. In general, the web of this diaphragm shall be located in the plane of the latticed flange.

70.180 Pin Connected Compression Members: All pin-connected compression members shall be provided with hinge plates having a minimum thickness of 3/8 inch.

BRACING

70.181 Stiffness: The ratio of unsupported length to least radius of gyration shall not exceed 140 for compression members.

The ratio of unsupported length to least radius of gyration shall not exceed 250 for tension members.

70.182 Design of Bracing: Lateral, longitudinal and transverse bracing shall be composed of angles or other shapes offering resistance to deformation when subjected to compressive stress, and shall have riveted connections.

In general, bracing shall consist of a double system of diagonal tension members with transverse compression members. The diagonals in each system shall be proportioned to carry the total lateral stress in tension, the transverse struts (or floor-beams) acting as compression members for both systems.

All intersections of lateral and sway bracing shall be riveted to add rigidity and prevent deformations.

70.183 Lateral Bracing: Bottom lateral bracing shall be provided in all bridges, except I-beam spans, from which it may be omitted. Bottom laterals preferably shall be supported by rigid hangers at the intersections.

Top lateral bracing shall be provided in deck spans and in through spans having sufficient head room.

Lateral bracing for compression chords shall preferably consist of either two or four angle latticed sections; and so designed as to effectively engage both flanges of the chords.

Lateral bracing shall have concentric connections to chords at end joints, and preferably throughout. The connections between the lateral bracing and the chords shall be designed to avoid, as far as possible, any bending stress in the truss members.

70.184 Portal and Sway Bracing: Through truss spans shall have portal bracing, preferably of the two plane or box type, rigidly connected to the end post and top chord flanges and constructed as deep as the minimum clearance will allow. When a single plane portal is used it preferably shall be located in the central transverse plane of the end posts, with diaphragms between the webs of the posts to provide for a proper distribution of the portal stresses. The portal bracing shall be designed to take one-half the full end reaction of the top chord lateral system and the end posts shall be designed to transfer this reaction to the truss bearings.

Deck truss spans shall have adequate sway bracing at the ends and at all intermediate panel points. This bracing shall occupy the full depth of the trusses below the floor system. The bracing shall be proportioned to transfer the end reaction of the top lateral system to the substructure.

Through truss spans shall have sway bracing at each intermediate panel point if the height of the trusses is such as to permit a depth of 5 feet or more for the bracing. When the height of the trusses will not permit of such depth the top lateral struts shall be provided with knee braces. Top lateral struts shall be at least as deep as the top chord. Sway bracing shall be of ample strength to transfer one-half of the wind pressure to the leeward truss.

70.185 Cross Frames: Deck plate girder spans shall be provided with cross frames at each end proportioned to resist all lateral forces, and shall have intermediate cross frames at intervals not exceeding 20 feet. These frames shall be connected to the outstanding legs of the stiffener angles and to the girder flanges.

70.186 Low Truss Spans: The vertical truss members and the floor beam connections of low truss spans shall be proportioned to resist a lateral force, applied at the top chord panel points of the truss, determined by the following equation:

$$R = 150 (A + P)$$

Where R = lateral force in pounds.

A = area of cross section of chord in square inches.

P = panel length in feet.

This rigidity may be secured in part by extending one or both of the floorbeam connection angles upward along the inside of the post. Outrigger brackets attached to the vertical posts on the outside of the trusses shall not be used.

70.187 Through Girder Spans: Through plate girder spans shall be stiffened against lateral deformations by means of gusset plates, or knee braces with solid webs, attached to the stiffener angles and floorbeams. If the unsupported length of the inclined edge of the gusset plate exceeds 60 times its thickness, the gusset plate shall have stiffener angles riveted along its edge.

These braces generally shall extend to the clearance line and preferably shall be spaced not farther apart than 20 feet.

70.188 Longitudinal Bracing: Longitudinal bracing of trestles and viaduct towers shall be proportioned to resist the same forces as provided by the transverse bracing. In towers of more than two vertical panels there shall be diagonal bracing in a horizontal plane at the top, bottom and alternate intermediate panel points.

70.189 Steel Trestles: Each trestle bent shall be composed of two columns braced together. The majority of bents shall be united in pairs, forming a tower which shall be rigidly braced on the four sides and have longitudinal and transverse struts at the bases.

70.190 Lateral Horizontal Bracing: No lateral or horizontal bracing shall be placed below high water.

RIVETS AND RIVETING

70.191 Rivet heads must be approved hemispherical shape and uniform size for the same size rivet throughout the work. They must be full, neatly finished and concentric with rivet holes. All rivets shall preferably be machine driven by direct riveting machines. Tightening loose rivets by recupping and calking will not be allowed. All loose, burned or otherwise defective rivets shall be removed and replaced. In removing rivets care shall be taken not to injure the adjacent metal, and if necessary they shall be drilled out.

70.192 Effective Diameter of Rivets: The effective diameter of rivets shall be the diameter of the cold rivet before driving.

70.193 Effective Bearing Area: The effective bearing area of a pin, bolt, or rivet shall be its nominal diameter multiplied by the thickness of the metal on which it bears.

70.194 Size of Rivets: Rivets shall be of the size specified but generally be $\frac{3}{4}$ inch or $\frac{7}{8}$ inch in diameter. $\frac{5}{8}$ inch rivets shall not be used in members carrying calculated stress except in $2\frac{1}{2}$ inch legs of angles and in flanges of 6 inch and 7 inch beams and channels.

The diameter of rivets in angles carrying calculated stress shall not exceed one-fourth of the width of the leg in which they are driven. In angles whose size is not so determined $\frac{5}{8}$ inch rivets may be used in 2 inch legs, $\frac{3}{4}$ inch rivets in $2\frac{1}{2}$ inch legs and $\frac{7}{8}$ inch rivets in 3 inch legs.

In no case, except in handrails, shall structural shapes be used which do not admit the use of $\frac{5}{8}$ inch diameter rivets.

70.195 Pitch of Rivets: The minimum allowable distance between centers of rivets shall be three times the diameter of the rivet, but preferably shall be not less than the following:

For $\frac{7}{8}$ inch diameter rivets	3 inches
For $\frac{3}{4}$ inch diameter rivets	$2\frac{1}{2}$ inches
For $\frac{5}{8}$ inch diameter rivets	$2\frac{1}{4}$ inches

The maximum allowable pitch in the line of stress shall not exceed 6 inches or 16 times the thickness of the thinnest outside plate or angle connected, except in angles having two gage lines with rivets staggered where the pitch in each line may be twice the above with a maximum of 10 inches.

In webs of members composed of two or more plates in contact, the rivets shall be spaced not more than ten inches between centers in gage and pitch, provided such rivets serve no other purpose than to hold the plates in close contact. Tension members composed of two angles in contact shall be stitch riveted using a pitch not greater than 12 inches.

70.196 Edge Distance of Rivets: The minimum distance from the center of any rivet to a sheared edge shall be:

- For $\frac{7}{8}$ inch diameter rivets $1\frac{1}{2}$ inches
- For $\frac{3}{4}$ inch diameter rivets $1\frac{1}{4}$ inches
- For $\frac{5}{8}$ inch diameter rivets $1\frac{1}{8}$ inches

The minimum distance from rolled or planed edges, except flanges of beams and channels, shall be:

- For $\frac{7}{8}$ inch diameter rivets $1\frac{1}{4}$ inches
- For $\frac{3}{4}$ inch diameter rivets $1\frac{1}{8}$ inches
- For $\frac{5}{8}$ inch diameter rivets 1 inch

The maximum distance from any edge shall be eight times the thickness of the thinnest outside plate, but shall not exceed 5 inches.

70.197 Long Rivets: Long rivets subjected to calculated stress and having a grip in excess of $4\frac{1}{2}$ diameters shall be increased in number at least one per cent for each additional $\frac{1}{16}$ inch of grip. If the grip exceeds 6 times the diameter of the rivet, specially designed rivets shall be used.

70.198 Rivets in Tension: Rivets in direct tension shall, in general, not be used. However, where so used their value shall be one-half that permitted for rivets in shear. Countersunk rivets shall not be used in tension.

BEAMS AND GIRDERS

70.199 Beam Bridges: Rolled shapes used for beam bridges shall be spaced and proportioned to carry the loads as specified. The separate lines shall be held truly to position by struts or spreaders. They shall be proportioned by the moments of inertia of their sections. Proper allowance shall be made for any reduction in strength due to rivet holes in the tension flange or for any reduction in allowable stress due to the length of unsupported compression flange.

70.200 Floorbeams: Floorbeams preferably shall be at right angles to the trusses or main girders and shall be rigidly connected thereto. In general, floorbeam connections shall be located above the bottom chord and, in riveted work, the bottom chord lateral system shall engage both the bottom chord and the floorbeam. Floorbeam connections to pin-connected trusses preferably shall be above the bottom chord pins but, if located below, the vertical posts shall be extended below the pins to secure rigid connections to the floorbeams.

70.201 End Floorbeams: Except in skew bridges end floorbeams shall be provided in all truss and girder spans. End floorbeams preferably shall be designed to permit the use of jacks for the future lifting of the superstructure, under which condition the specified unit stresses shall not be exceeded by more than 50 per cent.

70.202 Painting End Floorbeams: End floorbeams shall be arranged to permit future painting of the sides of the beams adjacent to the abutment backwalls.

70.203 Stringers: Steel stringers preferably shall be riveted between the floorbeams, with end connections to the floorbeam webs.

70.204 End Struts: When end floorbeams are not used the end panel stringers shall be secured in correct locations by end struts securely connected to the stringers and to the main trusses or girders. The end panel lateral bracing shall be rigidly attached to the main trusses or girders and shall also be attached to the end struts. Adequate provision shall be made for the expansion movement of stringers.

70.205 End Connections for Floorbeams and Stringers: The end connection angles of floorbeams and stringers shall be not less than $\frac{3}{8}$ inch in thickness. When milled ends are required, the thickness of connection angles shall be $\frac{1}{8}$ inch greater than for connection angles not required to be milled. Except in cases of special end floorbeam details, end connections for floorbeams and stringers shall be made with two angles at each end. Bracket or shelf angles which may be used to furnish support during erection shall not be considered in determining the number of rivets required to transmit end shears.

End connection angles shall develop the full depth of the webs by having a length as great as the flanges will permit.

In the preparation of end connection details, special care shall be exercised to provide ample clearance for the driving of field connection rivets.

The use of any type of floorbeam hanger which does not prevent all rotation or longitudinal motion of the floorbeam, will not be permitted.

70.206 Compression Flanges of Beams and Girders: The gross area of the compression flanges of beams and plate girders shall be not less than the gross area of the tension flanges.

The laterally unsupported length of the compression flanges of beams and girders shall not exceed 40 times the flange width. When the unsupported length of flange exceeds 12 times the flange width, the compressive stress in pounds per square inch shall not exceed

$$19000 - 250 \frac{L}{b} \text{ (Maximum value, 16000 lbs.)}$$

where

L = length, in inches, of unsupported flange, between lateral connections or knee braces.

b = flange width in inches.

70.207 Proportioning Plate Girders: Plate girders shall be proportioned either by assuming the flanges to be concentrated at their centers of gravity or by the moment of inertia of the net section. In the former case $\frac{1}{8}$ of the gross area of the web is available as net flange area but the effective depth shall not be assumed to be greater than the distance back to back of flange angles. For girders having unusual cross sections the moment of inertia method shall be used.

70.208 Flange Sections: The compression flange preferably shall be stayed against lateral deflection at intervals not exceeding 12 times its width.

The flange angles shall form as large a portion of the gross area of the flange as practicable.

When flange plates are used, at least one plate on the top flange shall extend the full length of the girder. Any additional flange plates shall be of such length as to allow two rows of rivets to be placed at each end of the plate beyond its theoreti-

cal end, and there shall be a sufficient number of rivets at the ends of each plate to develop its full stress value before the theoretical end of the next outside plate is reached.

Flange cover plates shall be equal in thickness, or shall diminish in thickness from the flange angles outward. No plate shall have a thickness greater than that of the flange angles.

70.209 Web Plates: Web plates shall be proportioned for both the vertical and horizontal shearing stresses. Splices in web plates shall be avoided as far as possible. The thickness of the web plate shall not be less than 1/180 of the distances between the toes of flange angles.

70.210 Flange Rivets: The number of rivets connecting the flange angles to the web plates shall be sufficient to develop the increment of flange stress transmitted to the flange angles, combined with any load that is applied directly to the flange.

70.211 Flange Splices: Splices in flange members shall not be used except by special permission of the Engineer. Two members shall not be spliced at the same cross section and, if practicable, splices shall be located at points where there is an excess of section. The net section of the splice shall exceed by 10 per cent the net section of the member spliced. Flange angle splices shall consist of two angles, one on each side. Splice angles shall be fitted to secure close contact with the material spliced.

70.212 Web Splices: Web plates shall be symmetrically spliced by plates on each side. The splice shall be equal in strength to the web in both shear and moment. There shall be at least two rows of rivets on each side of the joint.

70.213 End Stiffeners: Plate girders shall have stiffener angles over end bearings, the outstanding legs of which shall be as wide as the flange angles will allow and shall fit tightly against them. These end stiffeners shall be proportioned for bearing on the outstanding legs of the flange angles, no allowance being made for the legs fitted to the fillets of the flange angles. End stiffeners shall be arranged to transmit the total end reaction and to distribute it over the bearings. They shall not be crimped and the connection to the web shall contain a sufficient number of rivets to transmit the entire reaction.

70.214 Intermediate Stiffeners: Intermediate stiffener angles shall be riveted in pairs to the web of the girder. The outstanding leg of each angle shall have a width of not more than 16 times its thickness and not less than 2 inches plus 1/40 of the depth of the girder.

Intermediate stiffeners shall be spaced at intervals not exceeding:

- (a) 6 feet;
- (b) The depth of the web;
- (c) The distance given by the formula,

$$d = \frac{t}{40} (12000 - S)$$

Where d = distance between rivet lines of stiffeners, in inches.

t = thickness of web, in inches.

S = web shear, in pounds per square inch, at the point considered.

When the depth of the web between the flange angles or side plates is less than 60 times the web thickness, intermediate stiffeners may be omitted.

Intermediate stiffener angles shall be placed at points where concentrated loads come onto the flanges and shall be designed to transmit the reactions to the girder web. Such stiffeners shall not be crimped.

70.215 Ends of Through Girders: The upper corners of through plate girders, where exposed, shall be neatly rounded to a radius consistent with the size of the flange angles and the vertical height of the girder above the roadway. The first flange plate or a plate of the same width will be bent around the curve and continued to the bottom of the girder. In a bridge consisting of two or more spans only the corners on the extreme ends need be rounded, unless the spans have girders of varying heights, in which case the higher girders shall have their top flanges neatly curved down at the ends to meet the top corners of the girders in the adjacent spans.

70.216 End Bearings: End bearings of girders on masonry shall be raised above the bridge seat by metal pedestals or plates a height of at least 2 inches.

70.217 Sole and Masonry Plates: Sole and masonry plates shall each be not less than $\frac{3}{4}$ inch thick.

70.218 Web Plates: Web plates of girders which have no cover plates shall be flush with the backs of angles, or project above the same not more than one-eighth ($\frac{1}{8}$) inch, unless otherwise called for. When web plates are spliced, not more than one-fourth ($\frac{1}{4}$) inch clearance between ends of plates will be allowed.

70.219 Cover Plates: The cover plates of all girders shall not extend beyond the outer lines of rivets connecting them to the angles more than 8 times the thickness of the outside plate, and in no case more than five inches. If two or more plates are used, the thickness shall be decreased outward from the angles.

PIN CONNECTED TRUSSES

70.220 Rigid Members in Pin-Connected Trusses: Pin-connected trusses shall have stiff riveted members in the first two main panels of the bottom chords at each end of the span, and all web members performing the function of suspenders shall be of stiff riveted construction.

70.221 Eye-Bars: Eye-bar heads shall have a cross sectional area through the center of the pin hole exceeding that of the body of the bar by at least 40 per cent. The net section adjacent to the head shall be not less than that of the main body of the bar. The thickness of the bar shall be not less than $\frac{1}{8}$ of the width and not greater than 2 inches. The form of the head shall be submitted to the Engineer for approval before the bars are made. The diameter of the pin shall be not less than $\frac{2}{3}$ of the width of the widest bar connected.

70.222 Packing Eye-Bars: The eye-bars of a set shall be packed symmetrically about the central plane of the truss and as nearly parallel as practicable, but in no case shall the inclination of any bar to the plane of the truss exceed 1/16 inch per foot. Bars shall be packed as closely as practicable and held against lateral movement, but they shall be arranged so that adjacent bars in the same panel will be separated by at least $\frac{3}{4}$ inch.

All intersecting diagonal bars not far enough apart to clear each other at all times shall be well clamped together at intersections.

Steel filling rings shall be provided, when required, to prevent lateral movements of eye-bars or other members connected upon pins.

70.223 Pins: Pins shall be long enough to insure a full bearing on all parts connected upon the turned body of the pin. They shall be secured by recessed hexagonal nuts. The screw ends shall be long enough to admit of burring the threads. Members packed on pins shall be held against lateral movements, using filler rings if necessary.

70.224 Pin Plates: Where necessary, pin holes shall be reinforced by plates, some of which must be the full width of the member so the allowed pressure on the pins shall not be exceeded, and so the stresses shall be properly distributed over the full cross-section of all members. These reinforcing plates must contain enough rivets to transfer their proportion of the bearing pressure. At least one plate on each side shall extend not less than six (6) inches beyond the edge of the batten plates.

HANDRAIL AND CURB

70.225 Curbs: Concrete curbs shall be designed to resist a lateral force of not less than 500 pounds per linear foot of curb, applied at the top of the curb.

70.225a Railings: Substantial railings shall be provided along each side of the bridge for the protection of traffic. Preferably, the top of railing shall not be less than 3'-0" above the finished surface of the roadway adjacent to the curb and, when on a sidewalk, shall not be less than 3'-0" above the sidewalk floor.

In general, railings shall be of two classes, as follows:

1. Railings for the protection of pedestrians on bridges in cities and villages.
2. Railings suitable for use on country bridges which are not subject to general pedestrian traffic.

70.225b Metal Railings: Metal railings shall be designed to resist a horizontal force of not less than 150 pounds per linear foot, applied at the top of the rail, and a vertical force of not less than 100 pounds per linear foot.

Metal railings of the second class may consist of not less than two lines of horizontal rails of approved section.

Metal railings of the first class shall consist of an upper and lower horizontal rail connected by a suitable web. The clear distance between the top of curb or sidewalk and the lower rail shall not exceed 6 inches.

All connections to posts, truss members, etc., shall contain not less than two rivets or bolts each. Ample provision shall be made for movement due to temperature.

SHOP DRAWINGS

70.226 The Contractor shall furnish the Commission three sets of shop drawings for approval. For final approval he shall submit seven copies. The Contractor shall not start fabrication on any steel work until he has received final approval on the shop drawings.

The blue prints shall be made from ink tracings, neatly and accurately drawn on sheets 36 inches long and 22 or 24 inches wide.

When changes on submitted drawings are requested by the Commission and the Contractor makes any additional changes, other than those expressly requested, he shall attract attention to them on the next copy of blue prints submitted by under-scoring with colored crayon or other suitable means.

Upon completion of the work the original tracings of shop details become the property of the Commission.

70.227 Shipping Invoices: Complete copies of shipping invoices shall be furnished to the Engineer with each shipment. These shall show the scale weights of individual pieces.

70.228 Bench Marks: 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.

70.229 Weight Determination: The payment shall be based on the weight of metal in the structure, including field rivets, as previously specified. The weight of erection bolts, field rivets (in excess of number specified) and all boxes, crates or other containers used for packing, together with sills, struts, and rods used for supporting members during transportation shall be excluded.

Weights paid for shall be shop scale weights. If the total scale weight of any structure exceeds the computed weight by more than two (2) per cent, the weight in excess of two (2) per cent above the computed weight shall not be paid for.

Payment for all material used in full-size tests shall be made on a pound-price basis for pound-price contracts and, unless otherwise provided, on a basis of actual cost plus 10% for lump-sum contracts. The scrap value of all material tested to destruction shall be allowed as a credit upon such payments.

Payment will not be allowed for material used in full size tests, which does not comply with the specifications.

70.230 Variation in Weight: If the weight of any member is less than the computed weight by more than 2 per cent, it shall be cause for rejection.

The weight of steel shall be assumed at 490 pounds per cu. ft. The weight of cast iron shall be assumed at 450 pounds per cu. ft.

When the structure is to be paid for at a unit price per pound of metal, the total weight of the same shall be computed as follows: The weight of the members shall be calculated from the shop details. No deductions shall be made for pin holes, beam copings or cut flanges. All plates shall be estimated from the size billed and deductions made for cut corners. The weight of the heads only of shop rivets shall be computed. The weight of the field rivets as previously specified will be included in the total computed weight of the metal. No allowance will be made for erection bolts, drift pins, pilot nuts, driving caps, or for rivets in excess of the number specified to be furnished.

The weight of heads of shop driven rivets shall be included in the computed weight, assuming the weights to be as follows:

Diameter of Rivet	Weight for 100 Heads
1/2"	4.5 lbs.
5/8"	8.5 lbs.
3/4"	15.0 lbs.
7/8"	21.0 lbs.
1"	31.0 lbs.

The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of 10 per cent for fillets and overrun.

To the total computed weight of metal shall be added an allowance of 0.3 of one per cent for shop paint.

70.231 Finished work shall be weighed in the presence of the Inspector, if practicable. The Contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts.

70.232 Before final payment is made the Contractor shall furnish the Engineer two sets of bills showing tabulated scale weights and two sets of bills showing weights computed from Shop Detail Plans.

MEASUREMENTS AND PAYMENTS

70.233 Basis of Payment: The contract price for fabrication and erection of fabricated structural steel or furnishing and erecting plain structural steel, shall include all labor, materials, transportation, and paint necessary for the proper completion of the work. Payment will be made on a pound price or lump sum basis, as required by the terms of the contract. For the purpose of payment, such minor items as galvanized iron pipe, bearing plates, pedestals, etc., shall be considered as structural steel even though made of other materials.

When the contract price on superstructure exceeds \$10,000.00, the contractor will be allowed 60% of the contract price for structural steel for superstructure when delivered at the bridge site. Contractor may be required to show satisfactory evidence of ownership.

Payment will be made under

- Item 70. Fabricated Structural Steel (per pound or lump sum) Complete in place.
- Item 71. Plain Structural Steel (per pound or lump sum) Complete in place.

ITEM 72. GAS PIPE BRIDGE RAIL

72.01 Description: When so shown upon the plans, the Contractor shall furnish and erect gas pipe bridge rails of the size and style indicated, and when required it shall be painted to match the balance of the structure.

72.02 Materials: All pipes shall be first class wrought iron, of standard dimensions, new stock, smoothly finished and free from any defects which might affect the strength or durability. Fittings shall be of sound malleable cast iron, free from cold shuts or blow holes, true to form and thickness, and shall have a workmanlike finish. Unless otherwise provided, fittings shall be of the ball pattern, made especially for railings.

72.03 Construction: Shop drawings for rail must be submitted and approved before fabrication of rail is started. All pipe and fittings shall be cut, threaded, and coupled to proper lengths so that both posts and rails may be erected in exact position. They shall be attached to the superstructure by the methods shown upon the drawings. When this requires that holes in flanged bases or other parts shall match holes in the structural metal, the Contractor shall make all necessary arrangements to insure the proper agreement of the holes. When expansion sleeves are called for they shall be reamed to permit of free play in the direction of the expansion. Posts having their lower ends embedded in concrete shall be carefully set to insure their proper alignment and perpendicularity. They shall be set preferably in holes previously left for the purpose and grouted with Portland cement mortar. The completed rails shall be in perfect alignment both laterally and vertically and shall present a neat, finished appearance.

When erected, the rails shall be carefully cleaned of all dirt, rust, oil, grease or other objectionable matter and if painting is specified, shall be given three field coats of paint. The paint and method of application shall conform strictly to requirements for field coats of "Steel Structures".

72.04 Basis of Payment: The contract price for the foregoing work shall include all fittings and all bolts, fillers, and other parts necessary for the attachment of the rails, as well as the rails proper. The price shall be based upon the number of linear feet of gas pipe rail complete in place from end to end of rail along the center line of top rail and shall be complete compensation for all materials, equipments, tools, labor and incidental expense, for the work complete in place.

Payments will be made under

Item 72, Gas Pipe Bridge Rails, per foot of rail complete in place.

LOUISIANA HIGHWAY COMMISSION

PAMPHLET "N"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

NOVEMBER, 1931

Item 80. Untreated Structural Timber.

Item 81. Creosoted Structural Timber.

ITEM 80. UNTREATED STRUCTURAL TIMBER

ITEM 81. CREOSOTED STRUCTURAL TIMBER

81.01 Description: Untreated structural timber or creosoted structural timber shall be used where shown on the plans or directed by the Engineer, and such structures or portions of structures shall be constructed in accordance with the plans and specifications. This item shall include only such timber as is a part of the completed work. All timber for erection purposes, as falsework, forms, bracing, sheeting, etc., shall be furnished by the Contractor at his own expense.

81.02 Materials: Species: All Structural timbers shall be Southern Yellow Pine or as shown on plans or required in Special Provisions of contract.

81.03 Quality: (a) All timber shall be sound, sawed standard size, and, except as herein specified, shall be manufactured and graded in accordance with the requirements of the Manufacturer's Association grading rules for the species and grades specified.

(b) All timber shall be graded under the rules of the Southern Pine Association or the West Coast Lumbermen's Association as follows:

1. Southern Yellow Pine: All Southern Yellow Pine shall be "Structural Square Edge and Sound" for stringers, caps and all other members except handrail and handrail posts, which shall be "85% Heart Structural Square Edge and Sound-dry." Structural Square Edge and Sound shall conform to paragraphs No. 33 to No. 38 inclusive for measurements of timber 6" or larger and paragraphs No. 47 to No. 51 inclusive for measurements of lumber smaller than 6". 85% Heart material shall contain 85% heart wood and in other respects conform to paragraphs No. 33 to No. 38 inclusive, and paragraphs No. 47 to No. 51 inclusive, of the Southern Yellow Pine Association's Standard Specifications of March 23, 1927, for grades of Dense Long and Short Leaf Yellow Pine.

2. Douglas Fir: When Douglas Fir is specified it shall be a structural grade according to paragraph 218 of the standard grading and dressing rules for Douglas Fir, of the West Coast Lumbermen's Association.

81.04 Working Stresses: Working stresses for the different grades and classes of material shall be according to those specified on page 30 of the Southern Yellow Pine Association's Standard Specifications and page No. 58 of the West Coast Lumbermen's Standard Specifications, except as provided in these specifications.

81.05 Size: Unless otherwise specified on the plans, all timbers shall be furnished in the sizes shown. Rough timbers when sawed to standard size, shall mean that they shall not be over $\frac{1}{4}$ inch scant from nominal size specified. For instance a 12 x 12 inch timber shall measure not less than $11\frac{3}{4}$ x $11\frac{3}{4}$ inches.

Dressed: Standard dressing means that not more than $\frac{1}{4}$ inch shall be allowed for dressing each surface for timber 6" or larger, and $\frac{3}{16}$ " for lumber 5" or smaller. For instance a 12x12 inch timber after dressing four sides shall measure not less than $11\frac{1}{2}$ x $11\frac{1}{2}$ inches; a 2x4 inch piece of lumber after dressing four sides shall measure not less than $1\frac{5}{8}$ x $3\frac{5}{8}$ inches.

81.06 Treating Methods: Creosoted Timber and Piling: (a) Materials: Timber to be creosoted shall be of the quality specified and shall be air seasoned unless otherwise permitted by the Engineer. Piles shall be peeled, and all lumber shall be cut to size before treatment. No cutting or trimming will be allowed after treatment except the boring of the necessary bolt holes.

(b) Preservative: The preservative shall be the following grade of coal tar creosote oil, Grade 1, conforming to the standards of the American Wood Preserves Association, and shall meet the following requirements. The creosote must be a distillate of coal gas or coke oven tar.

CREOSOTE OIL—GRADE I

- | | |
|--|-------|
| 1. It shall not contain water in excess of..... | 3% |
| 2. It shall not contain matter insoluble in benzol in excess of..... | 0.5% |
| 3. Specific gravity of oil at 38°/15.5°, shall not be less than..... | 1.03% |
| 4. The distillate based on water free oil shall be within the following limits: Up to 210° C. not more than..... | 5% |
| Up to 235° C. not more than..... | 25% |
| 5. The float test of residue above 355° C., shall not exceed 50 sec. at 70° C., if the distillation residue above 355° C., exceeds | 5% |
| 6. Coke residue of oil, not more than..... | 2% |
| 7. The foregoing tests shall be made in accordance with standard methods of A. S. T. M. | |

(c) Method of Treatment:

1. Southern Yellow Pine: All Southern Yellow Pine shall be impregnated by an empty cell process with initial air so as to retain at least twelve (12) pounds of preservative oil per cubic foot of material, unless otherwise shown on the plans. In case the timber is to be prepared for treatment by steaming, the sap shall be vaporized and removed by subjecting the timber to a steam pressure of not less than fifteen (15) nor more than thirty (30) pounds per square inch for a period of not more than twenty (20) hours at not more than 274° F., which temperature and pressure maximum shall not be reached in less than two (2) hours, as the condition of the wood requires. As far as is practical in the opinion of the Engineer, all timber of the same size shall be treated at the same time. The sapwood shall be completely penetrated with the preservative and as much of the heart wood as practicable.

The timber shall be subject to air pressure of sufficient intensity and duration to provide under a vacuum the ejection of surplus preservative, and to insure a retention and proper distribution of the stipulated number of pounds of preservative per cubic foot of wood.

The preservative shall be introduced between 165° F. and 200° F., the cylinder pressure being maintained constant until the cylinder is filled with preservative. The pressure shall then be raised to and maintained at a minimum of 150 lbs. per square inch or until there is obtained the largest practicable volumetric injection that can be reduced to the stipulated retention by a quick high vacuum, 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 pressure is completed the cylinder shall be emptied speedily of preservative and a vacuum promptly created and maintained until the wood can be removed from the cylinder free of dripping preservative.

2. Douglas Fir: Green material or other material requiring seasoning is to be seasoned in creosote, under a vacuum in the treating cylinder. The creosote shall be heated to not less than 180° F., and not exceeding 200° F., for sawed lumber or timber, nor exceeding 220° for piling, and a vacuum shall be maintained at a minimum of 20 inches until the rate of condensation from the timber has been reduced to 1/10 pound of water per cubic foot per hour.

Kiln dried or sufficiently air dried material does not need to be further seasoned in this way, but shall be placed in a bath of creosote heated to 180° to 190° F., for not more than six (6) hours before subjecting it to pressure treatment.

Seasoned material and material to be seasoned should not be loaded in the same cylinder charge.

Material shall be subjected to the Empty Cell Treatment so as to retain at least eight (8) pounds of preservative oil per cubic foot unless otherwise specified. After the preliminary seasoning or heating period air pressure of sufficient intensity and duration to provide under a vacuum the ejection of surplus preservative and to insure a retention and proper distribution of the required number of pounds of preservative per cubic foot of wood, shall be created, and shall be maintained during the filling of the cylinder with creosote. Pressure shall then be applied to a maximum of 175 pounds per square inch for sawn lumber or timber; 200 pounds per square inch for piling, with the creosote heated to between 160° and 200° F., until the required absorption has been attained. The cylinder shall then be emptied and a vacuum of at least 20 inches shall be created and maintained until the material shall be free from dripping creosote. The depth of penetration of creosote absorbed should be as follows:

Piling .....	.75"
6 x 12s .....	.50"
12 x 12s and larger .....	.75"

As far as practical, in the opinion of the Engineer, all timber of the same size shall be treated at the same time. The amount of preservative shall be calculated on the basis of 100° F., from readings of working tank gauges.

81.07 Materials: Lumber and Timber: Lumber and timber shall conform to the requirements of these specifications. All lumber and timber shall be of the following grades:

I. Southern Yellow Pine:

- (a) All treated lumber or timber shall be structural Square Edge and Sound.
- (b) All untreated lumber in permanent work shall be 85% Heart and conform to requirements Structural Square Edge and Sound.
- (c) Lumber and Timber for temporary structures, which are for use only during erection, shall be No. I Common.

2. Douglas Fir: (a) All Douglas Fir shall be a structural grade according to paragraph 218 of the Standard Specifications of the West Coast Lumbermen's Association.

HARDWARE: Machine bolts, drift bolts and dowels, may be either wrought iron or medium steel. Washers shall be Ogee type wrought iron for 5/8" and 3/4" bolts and cut wrought iron for 1/2" bolts.

Machine bolts shall have square heads and nuts unless otherwise specified. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes, if specified.

Nails, spikes, bolts, dowels, washers and lag screws shall be black unless otherwise specified.

81.08 Storage of Material: 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.

81.09 Workmanship: Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed and all framing shall be true and exact. 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 the removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements of these specifications.

81.10 Treated Timber: Handling: Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with ropeslings. Cant dogs, peaveys, hooks or pike-poles shall not be used.

81.11 Framing and Boring: All cutting, framing and boring of treated timbers shall be done before treatment in so far as is practicable. In waters infested by marine borers, cutting and boring below high water shall be avoided.

81.12 Cuts and Abrasions: All cuts in treated piles or timbers and all abrasions after having been carefully trimmed, shall be covered 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.

81.13 Bolts: Bolts of diameters not exceeding 1 inch preferably shall be placed not closer than 6 inches center to center, not less than 6 inches from the center of the bolt to the end of any timber, and not less than 2½ inches from the center of the bolt to the side of any timber. These distances preferably shall be increased for bolts larger than 1 inch in diameter. Inclined bolts through timber preferably shall be provided with beveled cast washers to eliminate the cutting of inclined daps in the timber.

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81.14 Washers: For bolts in important locations, such as joints and splices, and for rods, the washers shall be designed to develop the bolt or rod in tension at the unit bearing stresses specified for compression perpendicular to the grain of timber.

81.15 Bolt Holes: Before driving bolts, hot creosote oil shall be poured into all bolt holes in such a manner that the entire surface of the hole shall be thoroughly coated with the oil. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

81.16 Untreated Timber: In structures of untreated timber the following surfaces shall be thoroughly coated with hot creosote oil before assembling. Ends, tops, and all contact surfaces of sills, caps, floor beams and stringers; and all ends, joints and contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth shall be similarly treated.

Bolts passing through non-resinous wood shall preferably be galvanized.

81.17 Holes for Bolts, Dowels: Holes for round drift bolts, and dowels shall be bored with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

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.

All bolts shall be effectually checked after the nuts have been finally tightened.

81.18 Hardware for Sea Coast Structures: The hardware used on structures on the sea coast preferably shall be galvanized.

81.19 Counter-Sinking: Counter-sinking shall be done wherever smooth faces are required. Recesses formed for counter-sinking shall be painted with hot creosote oil, and, after the bolt or screw is in place, shall be filled with hot pitch.

81.20 Framing: All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall make snug fit therein. No shimming will be permitted in making joints, nor will open joints be accepted. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

81.21 Concrete Pedestals: Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them.

Dowels of not less than $\frac{3}{4}$ 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.

81.22 Sills: Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift bolted to mud-sills or piles with bolts of not less than $\frac{3}{4}$ 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.

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

Posts shall be fastened to sills by one of the following methods, or as indicated on the plans:

(a) By dowels of not less than $\frac{3}{4}$ " diameter extending at least 6 inches into posts and sills.

(b) By drift bolts of not less than $\frac{3}{4}$ " diameter driven diagonally through the base of the post and extending at least 9 inches into the sill.

81.24 Caps: Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift bolts of not less than $\frac{3}{4}$ inch diameter extending at least 9 inches into the posts or piles. The drift bolts shall be approximately in the center of the post or pile.

81.25 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. In all cases spikes shall be used in addition to bolts.

81.26 Pile Bent Abutments: Pile bent abutments shall be adequately braced or anchored to resist earth pressure. Bulkhead plank shall be not less than 3 inches thick and preferably shall be treated. It shall be fastened to the piles with spikes, the length of which shall be at least 3 inches greater than the thickness of the plank.

81.27 Stringers: Stringers shall be sized at bearings and shall be placed in position so that knots near edges, particularly in the center half of span, 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 drift-bolting 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 in each end.

81.28 Flooring: Flooring on the roadway and sidewalk shall be of the dimensions and type as shown on the plans and shall be either (a) Plank Floor or (b) Laminated Floor. (a) Plank Floor shall consist of either creosoted or untreated planks laid heart side down and spiked to each stringer or nailing strip with two seven (7) inch spikes for four (4) inch plank and two six (6) inch spikes for three

(3) inch plank. Roadway planking shall be full length, no splicing permitted, and shall have a nominal thickness of either three (3) inches or four (4) inches and a nominal width of ten (10) inches. Untreated floor plank shall be surfaced four sides and laid with one-quarter ($\frac{1}{4}$) inch cracks and creosoted floor plank shall be either surfaced or rough lumber as provided for on plans and laid with one-quarter ($\frac{1}{4}$) inch cracks or jam as shown on plans. All floors of untreated planking shall be cut to a straight line along the sides of the roadway after planks are spiked into place. All creosoted floor plank must be cut to exact length before being creosoted and must be laid so that the ends make a straight line along each side of roadway. No cutting of the ends of creosoted plank will be permitted. Side walk floor plank shall have a nominal thickness of not less than two (2) inches.

(b) Laminated Floor shall consist of two (2) inch by four (4) inch or two (2) inch by six (6) inch creosoted strips placed on edge and each strip extending full width of the roadway. No splicing permitted. Unless otherwise specified, alternate strips are to be surfaced one side and one edge placed with rough side up and other strips are to be rough lumber, all strips must be accurately toe-nailed to each of the stringers with 30d wire nails and each strip shall be brought to bear firmly against the adjacent strip by nailing with a 40d wire nail between each pair of stringers.

81.29 Wheel Guards and Railings: Wheel guards and railings shall be accurately framed in accordance with the plans and erected true to line and grade.

Unless otherwise specified, wheel guards, rails and rail posts shall be surfaced on four sides (S4S).

Wheel guards shall be laid in sections not less than 12 feet long.

81.30 Painting: Untreated wood rails, posts and wheel guards shall be painted with three coats of white lead and oil paint conforming to the following specifications:

Pigment	9 pounds of Sublime White Lead
	3 pounds of Zinc Oxide
Vehicle	$\frac{3}{4}$ gallon Boiled Linseed Oil
	$\frac{1}{4}$ gallon Raw Linseed Oil.

A variation of 5% either way from the foregoing formula will be allowed.

White Lead, shall approach the composition: $2PbCO_3, Pb(CH_3)_2$. It shall not contain more than a trace of Sulphur Dioxide; not more than 2.50% of Sandy Lead; not more than 0.10% of Organic Matter; not more than 0.10% of Metallic Lead; not more than 0.50% of Lead Sulphate; not more than 0.15% of Ascetic Acid. It shall be of such fineness that not more than 0.50% remains after washing with water through a No. 21 silk bolting cloth screen.

Sublimed White Lead (Basic Sulphate of Lead), shall be amorphous in structure and must not be deficient in density or capacity and shall be free from adulterants. It shall contain not more than 5% of oxide of zinc (ZNO), and not more than 0.75% of Sulphur Dioxide, not less than 15% Lead Monoxide (PbO) and the remainder shall be Lead Sulphate ($PbSO_4$).

Zinc Oxide shall be finely ground and contain not less than 98% of zinc oxide (ZNO) and not more than 2% of grit or adulterants.

Raw Linseed Oil, shall conform to the current standard specifications of the American Society of Testing Materials.

Boiled Linseed Oil shall conform to the current standard specifications of the American Society of Testing Materials.

TESTING

Sample of Paint: Before ordering the paint, a sample of at least one quart shall be furnished the department, which sample if approved, will be used in determining the merits of the paints furnished on the work. All paint used must equal the sample in quality.

Samples of paint delivered, at the shop, and in the field, shall be furnished the Department by the Contractor. These samples shall be tested at such laboratory as the Department may direct before any paint is applied.

Delays: The Contractor should, therefore, secure the necessary paint in ample time so that no delay to the 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.

Guarantee: In order to prevent the necessary delays in collecting and testing samples, the Contractor may, at the discretion of the Department, submit a certificate of guarantee from the paint manufacturer stating that the paint which the said manufacturer intends to supply for a particular job has been previously tested and accepted by the Department and that the paint to be furnished is guaranteed to conform in every respect to the sample submitted to the Department for testing.

Parts of the structure, other than rails and rail posts, which are to be painted shall be designated on the plans or in the supplemental specifications.

Metal parts, except hardware, shall be given one coat of shop paint and after erection, two coats of field paint, as specified for "Structural Steel."

81.31 Design of Timber Bridges: The component parts of timber bridges shall be proportioned for the stresses produced by the following loads:

81.32 Dead Load: The dead load shall consist of the weight of that part of structure above the caps including the weight of the roadway floor, and gravel ballast where used.

81.33 Live Loads: The live load shall consist of either ten (10) or fifteen (15) ton trucks, as specified, distribution to be made and impact figured in accordance with "Loads" for steel bridges.

81.34 Unit Stresses: The unit stresses shall not exceed the following per square inch for creosoted "Structural Square-edge and Sound" Material:

Axial tension and bending stress.....	1600 pounds
Horizontal shear in bending.....	*125 pounds
(*100 Pounds per sq. in. for short leaf pine or Douglas Fir.)	

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Compression parallel to grain and bearing	1200 pounds
Compression for posts or columns for lengths of 0' to 10'	1000 pounds
Compression for posts or columns for lengths of 10' to 30'	1200-20 $\frac{L}{d}$
(Where L is the length in inches and d is the least dimension in inches.)	
Compression perpendicular to grain.....	275 pounds
Shear parallel to grain	*180 pounds
(*150 pounds per sq. in. allowable for Douglas Fir or Short leaf pine.)	

81.35 Columns and Posts: No column shall have an unsupported length greater than 30 times its least dimension.

The strength of built-up columns composed of two or more sticks bolted together, either with or without packing blocks, shall be considered as equal to the combined strength of the single sticks, each considered as an independent column.

81.36 Pile and Framed Bents: Pile Bents: Pile bents generally shall not exceed 40 feet in height. Pile bents 10 feet high or over shall be sway braced transversely with diagonal braces on each side of the bent, and shall be adequately braced longitudinally. In general, pile bents shall contain not less than 4 piles each and the outside piles preferably shall be battered. The piles shall be designed for safe bearing and for column action.

Framed Bents: Framed bents may be supported on piles, concrete pedestals or mud sills. All bents shall be sway braced transversely and adequate provision shall be made for longitudinal bracing. In general, framed bents shall contain not less than 4 posts each and the outside posts of the bent shall be battered. The posts shall be designed as columns.

81.37 Sills and Mud Sills: Mud sills, and all sills which are to be located in close proximity to the ground surface, preferably shall be given a preservative treatment. When possible, the design shall be such as to insure that sills will be located clear of all earth so that there may be a free circulation of air around them.

81.38 Caps: Timber caps shall be not less in size than 10 by 12 inches.

81.39 Bracing: Single story bracing shall not exceed 15 feet in height. The minimum size of transverse sway braces shall be 3 by 8 inches.

81.40 Bridging: Stringers shall be braced by cross bridging if the depth of stringers are over 3 times their thickness. The bridging shall be not less in size than 2" x 4".

81.41 Nailing Strips: When timber floors are supported by steel joists, the joists shall be provided with nailing strips which shall be bolted either to the top flanges or the webs.

When nailing strips are bolted to the flanges they shall be used on all joists. They shall be not less than 4 inches deep and shall be wider than the supporting flanges. They shall be secured with not less than 5/8 inch diameter bolts through the flanges,

spaced not more than 4 feet apart and not more than 18 inches from the ends of the strips.

Nailing strips bolted to the webs shall be not farther apart than 5 feet and shall be not less than 4 inches thick to provide a spiking face of sufficient width. They shall be held clear of the flanges by blocks between the web and strip, and bolted through the web with not less than $\frac{5}{8}$ inch diameter bolts spaced not more than 4 feet apart and not more than 18 inches from the ends of the strips.

81.42 Retaining Pieces: Retaining pieces, where required, shall be not less than 6 inches in width. In general they shall be secured in place by $\frac{5}{8}$ inch bolts at 3 foot intervals and spiked at 1 foot intervals.

81.43 Wheel Guards: Wheel guards having a cross section of not less than 4" x 6" shall be provided on each side of the roadway. The guard timbers shall be in lengths of not less than 12 feet. They shall be secured with $\frac{5}{8}$ inch bolts at the ends and at intermediate points not more than 5 feet apart.

In strip floors or cambered floors, not provided with retaining pieces, the wheel guards shall be placed directly on the flooring with scupper holes at suitable intervals. In other floors the wheel guards shall be supported by scupper blocks not less than 4 inches thick and 1 foot long, held in place by spikes and a bolt through the wheel guard and flooring, and spaced not more than 5 feet apart.

81.44 Cambered Floors: In strip floors or floors crowned for drainage the ends of the flooring shall be securely held down by the retaining pieces or wheel guards. In this case the bolts through the retaining pieces or wheel guards shall pass through the flooring and through the outside stringer or spiking piece.

81.45 Drainage: Adequate provisions shall be made for the proper drainage of timber floors.

81.46 Railings: Wood railings shall consist of not less than two horizontal lines of rails.

81.47 Method of Obtaining Inspection: The Contractor shall furnish the Commission, through the Resident Engineer, with a copy of each of his orders for creosoted and untreated lumber 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.

81.48 Method of Measurement: The pay quantities of lumber and timber will be the amount remaining in the finished structure, and computations of this amount shall be based upon the nominal or undressed size of cross-section and the actual lengths of pieces used. No allowance will be made for waste.

81.49 Basis of Payment: Lumber and timber shall be paid for at the contract price per thousand feet board measure (M.Ft.B.M.) for Item 80, "Untreated Structural Timber", or Item 81, "Creosoted Structural Timber", as the case may be, complete in place according to the plans or as directed by the Engineer, which price will include all materials, excavation, equipment, tools, labor, painting, preservation treatment, and all work incidental thereto. No additional allowance will be made for spikes, nails, bolts, rods, washers, drift bolts, metal covers for timber piers, where specified, etc.

PAMPHLET "0"

LOUISIANA HIGHWAY COMMISSION

STANDARD SPECIFICATIONS

FEBRUARY, 1929

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- Item 90. Precast Concrete Piles
 - Item 91. Untreated Timber Piles
 - Item 92. Creosoted Timber Piles
 - Item 93. Loaded Test Piles
 - Item 94. Unloaded Test Piles
 - Item 95. Timber Sheet Piling
 - Item 96. Steel Sheet Piling

ITEM 90. PRECAST CONCRETE PILING

90.01 Description: This item shall consist of piles precast of Portland Cement concrete made and reinforced in accordance with these specifications and in conformity with the pertinent designated plans. They shall be driven in accordance with these specifications, in the location and to the elevation as shown on the plans, or as directed by the Engineer.

90.02 Materials: All concrete materials and their preparation and placing shall be in accordance with the requirements for Class A Concrete. (All coarse aggregate to pass a 1-inch ring.) It shall be the charge of the Contractor to order materials for and cast and manufacture the requisite lengths and amount of piling to complete the required structure or work.

90.03 Design: Precast Concrete Piles shall be square, circular or octagonal in section, as shown on plans. If a square section is employed, the corners shall be chamfered at least one and one-half ($1\frac{1}{2}$) inches. Piles shall preferably be cast with a driving point, and for hard driving shall preferably be shod with a metal shoe of approved pattern. Piling may be either of uniform section or tapered as desired. Tapered piling shall not, in general, be used for trestle construction except for that portion of the pile which lies below the ground line; nor shall tapered piles be used in any location where the piles are to act as columns. In general, concrete piles shall have a cross-sectional area, measured above the taper, of not less than one hundred and forty (140) square inches and when they are to be used in salt water, they shall have a cross-sectional area of not less than two hundred and twenty (220) square inches.

The length shall not exceed 35' for 14" square piles, 55' for 16" square piles and 75' for 18" square piles, for piles driven through firm soil, and shall not exceed fifteen (15) times the average diameter for piles driven to rock through loose, wet soil, or filled ground. When lateral support is deficient so that the piles act as columns, they shall be designed as columns.

Reinforcement shall conform to the requirements for Reinforcing Steel of these Specifications, and the weight and dimensions shall be as shown on plans.

Reinforcement for precast concrete piling shall consist of longitudinal bars in combination with lateral reinforcement in the form of hoops or spirals. The longitudinal reinforcement shall not be less than one per cent and preferably not less than one and one-half ($1\frac{1}{2}$) per cent of the total cross section of the pile. The reinforcement shall be placed at a clear distance from the face of the pile of not less than two (2) inches and when the piles are for use in salt water or alkali soils, this clear distance shall be not less than three (3) inches. The driving point, and also the top of the pile shall be protected against impact by means of special spiral winding or bands designed for this purpose. The reinforcing system shall preferably be of the "unit" type, rigidly wired or fastened at all intersections and held to true position in the forms by means of concrete blocks or other suitable device. Where piles exceed fifty-five (55) feet in length, additional longitudinal reinforcement shall be added throughout the central one-third of the length. Piling under retaining walls, abutments, etc., shall be designed to withstand the lateral stresses induced. Piles shall

be designed to withstand the stresses induced due to lifting, assuming 100% impact (see paragraph 90.07).

Where waterproofing is to be used, special specifications will be given and the work shall be in accordance therewith.

90.04 Casting: Forms shall be accessible for tamping and consolidation of the concrete. Under good weather curing conditions, side forms may be removed at any time not less than twenty-four (24) hours subsequent to placing concrete, but the entire piles shall remain supported for at least seven (7) days, and shall not be subject to any handling stress until the concrete has set for at least twenty-one (21) days, and for a longer period in cold weather, the additional time to be determined by the Engineer.

Piling may be cast either in a vertical or horizontal position. When vertical forms are used, special care shall be exercised to puddle and tamp the concrete around the reinforcing and to avoid the formation of stone pockets. When horizontal forms are used, the piles shall not be cast in tiers.

During the placing of concrete, the forms shall be vibrated by tapping with a hammer or wooden maul. Concrete shall be placed continuously in each pile and shall be carefully spaded, puddled, and tamped, special care being exercised to avoid horizontal or diagonal cleavage planes, and to see that the reinforcement is properly embedded in the concrete.

90.05 Finish: As soon as the forms are removed, concrete piles shall be carefully pointed with 1 :2 mortar, filling up all cavities or irregularities.

Trestle piling exposed to view shall be finished above the ground line in accordance with the provisions governing the finishing of concrete columns. Foundation piling, that portion of trestle piling which will be below the ground surface, and piles for use in sea water or alkali soils shall not be finished except by pointing as above set forth.

90.06 Curing: Concrete piles shall be cured in accordance with the general provisions governing the curing of concrete as elsewhere provided. No pile shall be driven until it has set for at least thirty (30) days, and in cold weather for a longer period, as determined by the Engineer. Concrete piles for use in sea water or alkali soils shall be cured for not less than sixty (60) days before being used.

90.07 Storage and Handling of Precast Concrete Piling: 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 six hundred and fifty (650) pounds compression per square inch, or in the reinforcing steel in excess of twelve thousand (12000) 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.

90.08 Loads: Concrete piles, when properly designed, constructed and placed, may be subject to loads as determined by tests or formula, but not to exceed three hundred (300) pounds per square inch of total cross-section at the smallest effective point, and generally not to exceed twenty-five (25) tons per pile, with a maximum limit of thirty-five (35) tons per pile.

90.09 Preparation for Driving: Piles shall not be driven until after the excavation is complete. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.

90.10 Caps: The heads of all piles shall be protected by caps of approved design, preferably having a rope or other suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

90.11 Methods of Driving: Piles shall preferably be driven by means of a combination of a steam hammer and jets.

When conditions warrant and the written permission of the Engineer is secured, holes may be jetted first and piles placed therein and driven to secure the last few feet of their penetration.

90.12 Equipment for Driving: (a) Hammers. Piles shall be driven with steam hammers. Steam hammers for this purpose shall develop an energy per blow at each full stroke of the piston of not less than twelve thousand (12,000) foot pounds.

(b) 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 where piles are driven through water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

(c) Followers. The driving of piling by means of 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 ten 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.

(d) Water Jets. Water jets may be used in combination with a hammer. The volume and pressure of the water at the jet nozzles and the number of jets used shall be sufficient to freely erode the material adjacent to the pile.

If water jets and a hammer are used for driving, the jets shall be withdrawn and the piles shall be driven by the hammer to secure final penetration. This procedure may be varied if the desired results are not obtained.

90.13 Allowable Variation in Driving: Piles shall be driven with a variation of not more than one-quarter ($\frac{1}{4}$) inch per foot from the vertical or batter line indicated, with a maximum variation of the head of the pile from the position shown on the plans of not more than three (3) inches.

90.14 Determination of Bearing Values: The safe bearing values shall be determined by the following formulas:

$$P = \frac{2 W H}{S + 0.1} \text{ for single acting steam hammers.}$$

$$P = \frac{2 H (W + A p)}{S + 0.1} \text{ for double acting steam hammer.}$$

Where P = Safe bearing power in pounds.
S = The average penetration in inches per blow for the last ten (10) to twenty (20) blows.
W = Weight, in pounds, of striking parts of hammer.
H = Height of fall in feet.
A = Area of piston in square inches.
p = Steam pressure in pounds per square inch at hammer.

The above formulas are applicable only when

- (a) The hammer has a free fall.
- (b) The penetration is at a reasonably quick and uniform rate.
- (c) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

In case water jets are used in connection with the driving, the bearing value shall be determined by the above formulas from the results of driving after the jets have been withdrawn.

90.15 Extensions or "Build Ups." Extensions, splices, or "build ups" 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 forty (40) 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 seven (7) days and shall then be carefully removed and the entire exposed surface of the pile finished as above specified.

90.16 Test Piles: When required, the Contractor shall drive test piles of a length and at the location designated by the Engineer. These piles shall be of greater

sufficient length to afford a greater penetration than that assumed in the design, in order to provide for any variation in soil conditions. The total cost of driving test piles shall be paid for according to contract.

In general, the Contractor will be required to drive one (1) test pile for each foundation, and in trestle work at about three hundred (300) foot intervals.

90.17 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.

90.18 Basis of Payment: Payment for "Pre-Cast Concrete Piling" will include the cost of furnishing all materials, equipment, tools, labor and other items necessary for casting, curing, and driving the piles, as ordered, together with the cost of removal of any obstructions in order to obtain the total required penetration. Payment will be made on the basis of the actual number of linear feet ordered by the Engineer, from which a deduction of one-half ($\frac{1}{2}$) the contract price per linear foot will be made for the length of piling cut off as directed by the Engineer, and provided this cut-off exceeds one (1) foot for any particular pile. In case extensions or splices are necessary the length of extension cast on pile will be paid for at the contract price per linear foot in addition to the original length of the pile cast, but provided that no allowance will be made for extensions or splices made necessary by damage to the piles during driving. No allowance will be made for any piles that are not cast and driven in accordance with these specifications or as directed by the Engineer and accepted by him.

In case battered piles are shown on the plans or required by the Engineer, the rate of payment will not be changed.

The cost of metal shoes will be paid for as "Extra Work," but the placing thereof will be included in the contract price for piling.

Piles ordered and not driven shall be paid for as specified under "Extra Work" and shall thereafter become the property of the Commission.

Payment will be made under Item No. 90, "Pre-Cast Concrete Piling," per linear foot complete in place.

ITEM 91. UNTREATED TIMBER PILES

ITEM 92. CREOSOTED TIMBER PILES

91.01 Description: Untreated timber piling and creosoted timber piling shall consist of round or square timber of the kind and dimensions specified placed on the locations and to the elevations shown on plans or as directed by the Engineer and in conformance with these specifications.

91.02: Quality: All timber piling shall be cut from sound and solid 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% of the inner bark. No strip of inner bark remaining on the stick shall be over 3/4 inch wide or over 8 inches long, and there shall be at least one inch of clean wood surface between any two such strips. Not less than 80% 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% 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% of the length of the bend or 2 1/2 inches. All knots shall be trimmed close to the body of the pile.

91.03 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"
40 to 60 feet	7"
Over 60 feet	6"

The minimum diameter of piles at a section four feet from the butt, measured under the bark, shall be as follows:

Length of Pile	Diameter	
	Douglas Fir Southern Yellow Pine Southern Cypress	All other Species
	20 feet and under	11"	11"
21 to 30 feet	12"	12"
31 to 40 feet	12"	13"
Over 40 feet	13"	14"

The diameter of the piles at the butt shall not exceed 20 inches.

Square piles shall have the dimensions shown on the plans.

91.04 Limitation of Use: Untreated timber piles shall be used only below permanent ground water level and shall not be used in water which is infested by marine borers. In general creosoted piling will not be used as foundation piling above permanent ground water level.

91.05 Penetration: The minimum penetration shall be ten (10) feet in hard material and not less than one-third (1/3) the length of the pile, or twenty (20) feet in soft material.

For foundation work, no piling shall be used to penetrate a very soft upper stratum overlying a hard stratum, unless the piles penetrate the hard material a sufficient distance to rigidly fix the ends.

91.06 Preparation for Driving: Piles shall not be driven until after the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the excavation is placed.

91.07 Caps: When the nature of the driving is such as to unduly injure the pile or when the area of the head of any timber pile is greater than that of the face of the hammer, a cap of approved design 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. No driving will be permitted without the use of the follower block.

91.08 Collars: Collars or bands to protect piles against splitting and brooming shall be provided where necessary by the Contractor at his own expense.

91.09 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.

91.10 Splicing Piles: Full length piles shall always be used where practicable but if splices cannot be avoided, an approved method of splicing shall be used. 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.

91.11 Method of Driving: Piles shall be driven with gravity hammer, steam hammer, water jets, or a combination of water jets and hammer.

When conditions warrant, and with the written permission of the Engineer, holes may be jetted first and piles placed therein and driven to secure the last few feet of their penetration.

91.12 Equipment for Driving: (a) Hammers. Gravity hammers shall weigh not less than two thousand (2,000) pounds, and the fall shall be so regulated as to avoid injury to the pile, and in no case shall it exceed twenty (20) feet.

Single acting and double acting steam hammers shall develop an energy per blow at each full stroke of the piston of not less than eight thousand (8,000) foot pounds, and five thousand (5,000) foot pounds, respectively.

(b) Leads: Pile driver leads shall be constructed in such a manner as to afford freedom of movement to the hammer and they shall be held in position by guys or stiff braces to insure support to the pile driving. Except where piles are driven through water, the leads shall preferably be of sufficient length so that the use of a follower will not be necessary.

(c) Followers: The driving of piling by means of 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 ten 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.

(d) Water Jets: Water jets may be used, either alone or in connection with a hammer. The volume and pressure of the water at the jet nozzles and the number of jets used shall be sufficient to freely erode the material adjacent to the pile.

If water jets and a hammer are used for driving, the jets shall be withdrawn and piles shall be driven by the hammer to secure final penetration. With permission of the Engineer, this procedure may be varied if the desired results are obtained.

91.13 Allowable Variation in Driving: Piles shall be driven with a variation of not more than one-quarter ($\frac{1}{4}$) inch per foot from the vertical, or from the batter line indicated, with a maximum variation of the head of the pile from the position shown on the plans of not more than three (3) inches.

91.14 Determination of Bearing Values: The safe bearing values shall be determined by the following formulas:

$$P = \frac{2 W H}{S + 1.0} \text{ for gravity hammers.}$$

$$P = \frac{2 W H}{S + 0.1} \text{ for single acting steam hammers.}$$

$$P = \frac{2 H (W + A p)}{S + 0.1} \text{ for double acting steam hammers.}$$

Where P = Safe bearing power in pounds.
 S = The average penetration in inches per blow for the last five (5) to ten (10) blows for gravity hammers, and the last ten (10) to twenty (20) blows for steam hammers.
 W = Weight, in pounds, of striking parts of hammer.
 H = Height of fall in feet.
 A = Area of piston in square inches.
 p = Steam pressure in pounds per square inch at hammer.

The above formulas are applicable only when

- (a) The hammer has a free fall.
- (b) The head of the pile is free from broomed or crushed wood fiber.
- (c) The penetration is at a reasonably quick and uniform rate.
- (d) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

Piles shall be driven to a bearing value as determined by the above formulas which shall, in no case, be less than ten (10) tons, nor shall any pile be driven beyond a point such as will give it a computed bearing value of thirty-five (35) tons. In driving timber piling in very soft material the above formulas may be applied not more than twelve (12) hours after driving.

In case water jets are used in connection with the driving the bearing value shall be determined by the above formulas from the results of driving after the jets have been withdrawn.

91.15 Storage and Handling: The method of storage and handling shall be such as to avoid injury to the piling. Special care shall be taken to avoid breaking the surface of treated piles; cant-dogs, hooks or pike-poles shall not be used. Cuts or breaks in the surface of treated piling shall be given three (3) brush coats of hot creosote oil of approved quality and hot creosote oil shall be poured into all bolt holes.

91.16 Elevation of Cut-off: The tops of all piling shall be sawed off at right angles to their axes 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. All piles raised during the process of driving adjacent piles shall be driven down again if required by the Engineer. Timber piling supporting concrete footings shall be embedded at least 12" in the footing.

91.17 Treatment of Pile 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:

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 and 18 inches square. The cover shall be bent down over the pile at an angle of approximately 45 degrees.

91.18 Pile Splices: Whenever the Engineer considers it necessary to splice piling which are delivered on the work the standard splice shall be used (B-2-60B). This splice consists of four (4) 3" x 8" timbers 8'0" long bolted to each section of the pile with seven (7) $\frac{3}{4}$ " x 16" bolts with ogee washers, after each section of pile has been squared up a minimum distance of 4'0" back from splice. For each splice

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made at the direction and under the supervision of the Engineer an extra allowance of ten (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.

91.19 Test Piles: When required, the Contractor shall drive test piles of a length and at the location designated by the Engineer. These piles shall be of sufficient length to afford a greater penetration than that assumed in the design, in order to provide for any variation in soil conditions. The total cost of driving test piles shall be paid for according to contract.

In general, the Contractor will be required to drive one (1) test pile for each foundation, and in trestle work at about three hundred (300) foot intervals.

91.20 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.

91.21 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.

91.22 Basis of Payment: The work shall be paid for at the contract price per linear foot for Item 91, "Untreated Timber Piling," or Item 92, "Creosoted Timber Piling," as the case may be, complete in place, which price will include the cost of furnishing all materials, including collars, galvanized iron covers, equipment, tools, labor and other items necessary for driving and cutting off such piles as are required. It shall also include the placing, but not the furnishing, of metal shoes, and the furnishing and placing of any temporary bracing necessary to hold the piles in alignment.

The number of linear feet to be paid for at contract price shall be the actual number of feet remaining in the finished structure. In addition to this, payment will be made for all cut offs on a basis of sixty (60) per cent of contract price, provided this cut-off is not necessitated by unnecessary brooming, splitting, or other injuries resulting from careless driving and is over one foot (1' 0") long on any particular pile. No allowance will be made for any piles which are not driven in accordance with these specifications or as directed by the Engineer and accepted by him, or for piles driven in falsework, or for piles used in bracing. The price per linear foot will also include wrapping, bolting or fastening timber fender piles, and the materials used therefor. In case battered piles are shown on the plans or required by the Engineer, the rate of payment will not be changed.

ITEM 93. LOADED TEST PILES

ITEM 94. UNLOADED TEST PILES

93.01 Description: Loaded test piles shall consist of loading any type of pile with twice the loading specified on the plans. Loaded test piles will be driven where directed by the Engineer and in accordance with these specifications.

Loaded and Unloaded Test Piles shall be of timber and of the same cross-section as the piling called for on the plans. They shall be of such length and shall be driven as directed by the Engineer.

93.02 Driving: Loaded and Unloaded Test Piles shall be driven under conditions similar to those obtaining for the permanent work. When test piles are driven to determine the length of foundation piles required for a pier or abutment, it will be necessary to excavate a hole from surface of the natural ground to elevation of bottom of footing as shown on plans and keep this excavation open during the driving and loading of test piles, so that the driving and loading conditions will be representative of actual conditions of load on permanent piles.

93.03 Method of Testing: (a) Loaded Test Piles. After the pile of the type specified by the Engineer has been driven in accordance with the requirements of the specifications for that type and to a capacity as determined by paragraph 90.14 or 91.14 it shall be loaded. The loading material shall be of any kind approved by the Engineer. The loading platform or box shall be so constructed that readings may be taken directly on the pile. This platform or box shall be so built as to carry safely, in the opinion of the Engineer, an amount of the approved material equal in weight to twice the loading shown on the plans. Before the platform or box is constructed any split or broomed portion of the pile shall be cut off, leaving a sound surface to support the box.

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 twenty-four (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 one-half ($\frac{1}{2}$) the load carried by the pile without exceeding a total permanent settlement of one-quarter ($\frac{1}{4}$) inch in forty-eight (48) hours, unless otherwise specified by the Engineer.

(b) Unloaded Test Piles: Piles of this type shall be driven in accordance with the specifications for the particular type of piling shown on the plans. The piles shall be driven until the capacity as determined by formula is equal to that 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 as specified under paragraph 90.11 or 91.11.

93.04 Basis of Payment: (a) Loaded Test Piles. This work shall be paid for at the contract unit price each for Item 93, "Loaded Test Piles." This price will include the test pile and all materials, equipment, tools, labor and work incidental to

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contracting the platform or box, procuring and placing the loading material removing both the test pile, platform or box and material, and disposing of same as directed by the Engineer. No payment will be made for test loadings made or test piles driven that are not in accordance with these specifications or as directed by the Engineer and accepted by him.

(b) Unloaded Test Piles: This work will be paid for at the contract unit price each for Item 94, "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.

ITEM 95. TIMBER SHEET PILING

95.01 General: This specification covers only such sheet piling as is shown upon the plans, or as ordered by the Engineer, to be left in place so that it becomes a part of the finished structure.

95.02 Material: The timber, unless otherwise definitely noted upon the plans or specified, 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.

These 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 three planks securely fastened together. The piles shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together.

95.03 Construction: The tops of the piles shall be cut off to a straight line at the elevation indicated and shall be braced with a waling strip, properly lapped and joined at all splices and corners. The wales shall preferably be in one length between corners and shall be bolted near the tops of the piles. When in contact with a concrete footing, the waling strips shall be placed upon the outside of the piles at such an elevation that it can be braced with steel tie-rods embedded in the concrete footing.

95.04 Driving: Sheet piling shall be driven with either a maul, sledge, gravity or steam hammer, as approved by the Engineer. In case it is necessary, in order to obtain the penetration required, the piling shall be jetted.

95.05 Basis of Payment: Payment will be made at the contract price per thousand feet board measure, for Item 95, "Timber Sheet Piling," which price will include the cost of furnishing, driving and cutting off such piles as are required. Payment will be made only for that portion remaining in place and no allowance will be made for material cut off, or for any piling that is not driven in accordance with these specifications, or as directed by the Engineer and accepted by him.

ITEM 96. STEEL SHEET PILING

96.01 General: This specification covers only such sheet piling as is shown upon the plans, or as is ordered by the Engineer, to be left in place so that it becomes a part of the finished structure.

96.02 Material: All steel used for sheet piling shall conform to the requirements of the Standard Specifications for Structural Steel for Bridges, Serial Designation A-7-24, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

The sections when assembled in place shall be watertight at the joints.

96.03 Construction: The tops of the piles shall be cut off to a straight line at the elevation indicated and shall be braced with a waling strip properly lapped and joined at all splices and corners. The wales shall preferably be in one length between corners and shall be bolted near the tops of piles. When in contact with a concrete footing the waling strips shall be placed upon the outside of the piles at such an elevation that it can be braced with steel tie-rods embedded in the concrete footing.

96.04 Driving: Sheet piling shall be driven with either a maul, sledge, gravity or steam hammer as approved by the Engineer. In case it is necessary in order to obtain the penetration required, the piling shall be jetted.

96.05 Basis of Payment: Payment will be made at the contract price per pound for Item 96, "Steel Sheet Piling," which price will include the cost of furnishing, driving and cutting off such piles as are required. Payment will be made only for that portion remaining in place and no allowance will be made for material cut off, or for any piling that is not driven in accordance with these specifications, or as directed by the Engineer and accepted by him.

INCIDENTAL WORK

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STANDARD SPECIFICATIONS

NOVEMBER, 1930

Item 110.	Plain Rip Rap.
Item 111.	Grouted Rip Rap.
Item 112.	Plain Cement Concrete Curbing.
Item 113.	Plain Rubble Gutter.
Item 114.	Grouted Rubble Gutter.
Item 115.	Plain Cement Concrete Gutter.
Item 116.	Combination Cement Concrete Curbing and Gutter.
Item 117.	Repaved Stone Gutter.
Item 118.	Repaved Brick Gutter.
Item 119.	Reset Curbing.
Item 120.	Reset Combination Curbing and Gutter.
Item 121.	Stone Underdrains.
Item 122.	Shoulder Drains.
Item 123.	Steel Fabric or Mesh Reinforcement.
Item 125.	Salvaged Gravel.
Item 125-A	Overhaul on Salvaged Gravel.
Item 130.	Removal of Existing Culverts.
Item 134.	Rebuilt Guard Rail.
Item 135.	Removal of Existing Bridges.
Item 141.	Removal and Relocation of Buildings, Structures, etc. General Special Provisions.

ITEM 110. PLAIN RIP RAP

110.01 Description: This item shall consist of furnishing and laying rip rap on slopes, shoulders, or at piers and abutments as shown on the plans or as directed by the Engineer, in accordance with these specifications and in conformity with the indications on the plans.

110.02 Materials: The stone shall be sound and durable and shall weigh not less than one hundred and thirty (130) pounds per solid cubic foot. Unless otherwise especially provided, from fifty (50) to sixty (60) per cent of the stone shall weigh between seventy-five (75) and one hundred and fifty (150) pounds each, and of the remainder forty (40) to fifty (50) per cent shall be graded in size from seventy-five (75) pounds to pieces weighing not less than ten (10) pounds.

110.03 Placing: The Rip Rap, graded so that the smaller stone is uniformly distributed through the mass, shall be dumped promiscuously over the area designated until the required depth has been obtained.

110.04 Method of Measurement: When Rip Rap is shipped in, it will, unless otherwise specified, be furnished by the Commission, F. O. B. car sidings, at delivery points indicated on the plans, and will be measured by actual weight and the railroad track scale bill of lading weights shall govern. However, in the absence of railroad weights, the Rip Rap shall be accurately measured, and for the purpose of payment, one (1) cubic yard of rip rap shall be considered to weigh twenty-six hundred (2600) pounds.

When so indicated on the plans, or as directed by the Engineer, Rip Rap, composed of demolished concrete headwalls, culverts, or bridges will be used and will be measured by the cubic yard in wagons or trucks, and the price bid on this item shall include the hauling as well as the placing of this material.

110.05 Basis of Payment: This work will be paid for at the contract unit price per ton for "Plain Rip Rap", complete in place, which price shall include all materials (unless otherwise provided), equipment, tools, labor and all work incidental to complying with these specifications.

ITEM 111. GROUTED RIP RAP

111.01 Description: Grouted rip-rap shall be composed of approved stone, grouted in place, laid on slopes to protect them from washing at places indicated on the plans or where directed by the Engineer in accordance with these specifications.

111.02 Materials: The cement and sand shall comply with the requirements given under "Concrete". The stone may be of any material which is sound, durable, free from segregation riffs or seams or any other defect operating to destroy its natural resistance to the elements and shall be as nearly rectangular in section as is practicable. Unless otherwise specifically provided, all stone shall weigh between sixty (60) and two hundred and fifty (250) pounds each, and at least sixty (60) per cent shall weigh over one hundred and fifty (150) pounds each.

111.03 Grout: Grout shall be composed of one (1) part Portland cement and three (3) parts of sand. The sand and cement shall be mixed dry in a water-tight box until the mixture assumes a uniform color, after which water shall be added, as the mixing continues, until the grout attains a thick creamy consistency so that it can be easily handled and spread with a trowel.

Grout which is not used within thirty (30) minutes after water has been added shall be wasted. Retempering of grout will not be permitted.

111.04 Construction: Slopes shall be no steeper than the angle of repose, unless otherwise indicated on the plans or directed by the Engineer. The stones shall be placed with their beds at right angles to the slope, the larger stones being used at the bottom of the slope, and the smaller stones at the top of the slope. They shall be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not by the adjacent stones. The spaces between the stones shall be completely filled with grout from bottom to top. The thickness of the finished rip-rap shall be not less than eight (8) inches thick, measured perpendicular to the slope. The finished surface of the rip-rap shall present a reasonably even surface and finished surface shall not vary from the lines, grades and sections given by more than two (2) inches at any point.

111.05 Protection: No rip-rap shall be grouted in freezing weather without the permission of the Engineer and the use of such precautions as he may approve. In hot or dry weather the rip-rap shall be protected from the sun and kept moist for at least three (3) days after grouting.

111.06 Basis of Payment: This work will be paid for at the contract price per square yard for "Grouted Rip-Rap," complete in place, which price will include all necessary excavation, preparation of sub-grade, materials, equipment, tools, labor and work incidental thereto.

Toe walls shall be paid for at the contract price per square yard of vertical projection.

ITEM 112. PLAIN CEMENT CONCRETE CURBING

112.01 Description: This curbing shall consist of cement concrete composed of one (1) part of Portland Cement, two (2) parts of fine aggregate and three and one-half ($3\frac{1}{2}$) parts of coarse aggregate, constructed in accordance with the plans and in conformity with these specifications. The standard curbing shall be six (6) inches in width, eighteen (18) inches in depth and in lengths of ten (10) feet.

112.02 Materials for Concrete: The Portland Cement, fine aggregate, coarse aggregate and water for the concrete shall meet the requirements of Paragraphs 36.03, 36.09, 36.10, 36.11, 36.12, 36.13 and 36.14, respectively, except the maximum size of the coarse aggregate shall not exceed in size such material as passes a laboratory sieve having square openings of one and one-half ($1\frac{1}{2}$) inches.

112.03 Forms: The forms for the curbing 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 (3) stakes shall be provided for each ten (10) feet. If of wood, they shall be of two (2) inch surfaced plank; or of metal, they shall be of approved section and shall have a flat surface on top. These forms shall be of approved section and shall have a flat surface on top. These forms shall be of a depth equal to the depth of the curbing, 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 of one (1) inch from the top of the curbing to the finished surface line of the pavement, 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.

112.04 Excavation for Curbing: Excavation shall be made to the required depth and the subgrade or base upon which the curb is to be set shall be compacted to a firm, even surface. Where foundation underdrain is to be placed under the curbing, the excavation for the curbing shall be made in conjunction with the excavation for the underdrain.

112.05 Placing Concrete: The concrete shall be mixed as specified in Paragraphs 60.10 and 60.12 of Pamphlet "L" and shall be placed in the forms to the depth specified, in layers of four (4) or five (5) inches, tamped and spaded until mortar entirely covers its surface. Where indicated or directed, drainage openings shall be made through the curbing at the elevation and of the size required. The top of the curbing shall be floated smooth and the outer edge shall be rounded to a radius of one (1) inch while the concrete is still soft.

112.06 Forming Joints: The curbing shall be constructed in uniform lengths of sections of ten (10) feet, except where shorter sections are necessary for closures, but no section shall be less than four (4) feet. These sections shall be separated by sheet steel templates set perpendicular to the face and top of the curbing. These templates shall be one-eighth ($\frac{1}{8}$) of an inch in thickness and of the width of the curbing, and not less than two (2) inches greater than the depth of the curbing. The templates shall be set carefully during the placing of the concrete and allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

112.07 Finishing: The forms shall be removed within twenty-four (24) hours after the concrete has been placed. Honeycombed places and other minor defects shall be filled with mortar composed of one (1) part of Portland Cement and two (2) parts of fine aggregate which shall be applied with a wooden float. Plastering shall not be permitted on the faces of the curbing and all rejected curbing shall be removed and replaced without additional compensation. The top and face of the curbing, from the top to eight (8) inches below, shall be finished while the concrete is still green by wetting a soft brick or wood block and rubbing the surface until it is smooth. Plenty of water shall be used, either by dipping the brick or block in water or by throwing water on the curbing with a brush. When completed the curbing shall be protected from the elements in a satisfactory manner for a period of three (3) days or longer if directed.

112.08 Intersections: Curved curb at street intersections shall be constructed with a minimum radius of five (5) feet, and shall be protected with an armor bar extending entirely around the curve and one (1) foot beyond each end, when so shown on the plans.

112.09 Drainage Openings: Where indicated on the plans or ordered by the Engineer, drainage openings shall be made through the curbing at the elevation and of the size required.

112.10 Refilling: After the concrete has set sufficiently, the space in front and back of the curbing shall be refilled to the required elevation with suitable material which shall be tamped in layers of not more than six (6) inches until firm and solid.

112.11 Method of Measurement: This item will be measured by the linear foot, complete in place.

112.12 Basis of Payment: This work will be paid for at the contract unit price per linear foot for "Plain Cement Concrete Curbing", complete in place, which price shall include all materials, forms, equipment, tools, labor and work incidental thereto, and the excavation for curbing, refilling and the satisfactory disposal of surplus material.

ITEM 113. PLAIN RUBBLE GUTTER

ITEM 114. GROUTED RUBBLE GUTTER

113.01 Description: This gutter shall consist of stones, six (6) to eight (8) inches in depth, with a dry or cement-grout filler, and a foundation, approximately four (4) inches in depth, constructed on a prepared subgrade, in accordance with the dimensions indicated on the plans and to conform to these specifications.

113.02 Foundation Material: The material for the foundation shall consist of approved, clean, sound, durable crushed rock, slag screenings or gravel of such size that when dry it shall pass through a laboratory sieve having square openings of three-fourth ($\frac{3}{4}$) of an inch, well graded from coarse to fine, containing not more than ten (10) per cent of clay, loam or other foreign substances.

113.03 Gutter Stone: The gutter stones shall consist of approved, sound, durable rubble stone or rounded river or bank stone, which shall not be less than six (6) nor more than eight (8) inches in depth and shall have a top surface width of not less than two (2) inches and a length not less than the depth. All gutter stone shall be inspected thoroughly before and after laying and all rejected material shall be removed immediately from the work.

113.04 Dry Filler: The material for filling the spaces between gutter stones shall consist of approved, clean gravel, coarse sand or stone screenings of such size that when dry will pass through a laboratory sieve having square openings of three-quarter ($\frac{3}{4}$) of an inch and not less than one-quarter ($\frac{1}{4}$) of an inch, well graded from the maximum size down.

113.05 Grout Filler: The cement grout for filling the spaces between gutter stone shall consist of mortar of one (1) part of Portland Cement and two (2) parts of sand, thoroughly mixed by hand or machine. The cement shall meet the requirements of Paragraphs 36.03 of Pamphlet "G" and the sand of Paragraph 36.10 of Pamphlet "G".

113.06 Laying Gutter: The subgrade shall be formed at a depth of not less than ten (10) inches below and parallel with the finished surface of the gutter. All soft and yielding or other unsuitable material shall be removed and the subgrade shall be compacted thoroughly and finished to a smooth, firm surface.

The approved foundation material shall be spread on the prepared subgrade to form a bed approximately four (4) inches in depth.

The gutter stone shall be bedded in the foundation perpendicular to the finished surface, with the flat surface up, in straight rows, with longest dimensions at right angles to the center line of the gutter and in close contact. They shall break joints satisfactorily and no interstices exceeding one (1) inch in width shall exist.

The stone shall be rammed thoroughly until the surface is firm and conforms to the finished grade and cross section.

113.07 Filling Gutters: When the dry filler is to be used, while being rammed, the approved gravel, sand or screenings shall be swept into the spaces between the stones until they are filled. Any gutter having an irregular or uneven surface shall be taken up and reset satisfactorily. After ramming, one (1) inch of the approved paving gravel, sand or screenings shall be spread evenly over the surface.

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When grout filler is to be used, while being rammed, the spaces shall be filled with the approved gravel, sand or screenings to within four (4) inches of the top and any irregularities in the gutter shall be corrected, after which, the cement grout shall be poured and broomed into the spaces between and over the stones, this operation being continued until the grout remains flush with the tops of the stones. The paving shall be protected for at least three (3) days after grouting, and no grout shall be placed in freezing weather.

113.08 Method of Measurement: This plain and grouted rubble gutter shall be measured by the square yard, complete in place.

113.09 Basis of Payment: This work will be paid for at the contract price per square yard for, "Plain Rubble Gutter" or "Grouted Rubble Gutter" as the case may be, complete in place, which price shall include all excavation, materials, equipment, tools, labor and work incidental thereto.

Payment will be made under,

Item 113. Plain Rubble Gutter, (per square yard) complete in place.

Item 114. Grouted Rubble Gutter, (per square yard) complete in place.

ITEM 115. PLAIN CEMENT CONCRETE GUTTER

ITEM 116. COMBINATION CEMENT CONCRETE CURBING AND GUTTER

115.01 Description: This gutter, or curbing and gutter, shall consist of concrete, composed of one (1) part of Portland Cement, two (2) parts of fine aggregate and three and one-half ($3\frac{1}{2}$) parts of coarse aggregate, constructed in accordance with these specifications on the prepared subgrade in one (1) course. The dimensions shall be those shown on the plans.

The standard plain cement concrete gutter shall be six (6) inches in depth, of the width shown on the plans, and cast in alternate lengths of ten (10) feet.

The standard combination cement concrete curbing and gutter shall be cast continuously; the gutter shall be six (6) inches in depth, and of the width shown on the plans, and the curbing shall be six (6) inches in width and twelve (12) inches in depth, unless otherwise shown on plans.

115.02 Materials for Concrete: The Portland Cement, fine aggregate, and coarse aggregate and water for the concrete shall meet the requirements of Paragraphs 36.03, 36.09, 36.10, 36.11, 36.12, 36.13 and 36.14 of Pamphlet "G", except the maximum size of the coarse aggregate shall not exceed in size such material as passes a laboratory sieve having square openings of one and one-half ($1\frac{1}{2}$) inches.

115.03 Placing Concrete: The subgrade shall be formed at the required depth below the finished surface of the gutter, in accordance with the dimensions and design shown on the plans for the bottom of the gutter. All soft and yielding or otherwise unsuitable material shall be removed, and the subgrade shall be compacted thoroughly and finished to a firm, smooth surface. If the soil requires a sub-base, gravel or cinders to a thickness of six (6) inches may be used.

The plain cement concrete gutter shall be constructed continuously. Expansion joints shall be provided by inserting prepared sheets of asphaltic felt, or other bituminous filler of the quality specified in Paragraphs 36.18, 36.19, and 36.20, of Pamphlet "G" and not less than one-half ($\frac{1}{2}$) inch thick. The edges of the gutters shall be finished with an approved edging tool, of a radius as shown on the plans.

Combination cement concrete curbing and gutter shall be constructed in all respects as specified above, the face and top of the curbing shall be floated smooth and the edge shall be rounded to a radius of one (1) inch while the concrete is still soft, and the face and the top of the curbing shall be finished by removing the forms within twenty-four (24) hours after the concrete has been placed. Honeycombed places and other minor defects shall be filled with mortar composed of one (1) part of Portland cement and two (2) parts of fine aggregate which shall be applied with a wooden float.

115.04 Intersections: Curved curb at street intersections shall be constructed on a radius as shown on the plans, and shall extend entirely around the curve and one (1) foot beyond each end.

115.05 Protection: When completed, the concrete shall be kept moist for a period of not less than three (3) days or longer if directed, and shall be protected from the elements in a satisfactory manner.

115.06 Drainage Openings: Where indicated on the plans or ordered by the Engineer, drainage openings shall be made through the curbing at the elevation and of the size required.

115.07 Refilling: After the concrete has set sufficiently, the spaces on both sides of the gutter, or the curbing and gutter, shall be refilled to the required elevation with suitable material, which shall be compacted in layers of not more than six (6) inches until firm and solid.

115.08 Method of Measurement: The item of plain cement concrete gutter will be measured by the square yard, complete in place. The item of combination cement concrete curbing and gutter will be measured by the linear foot, complete in place.

115.09 Basis of Payment: The item of plain gutter will be paid for at the contract unit price per square yard for "Plain Cement Concrete Gutter," complete in place, and the item of combination curbing and gutter will be paid for at the contract unit price per linear foot for "Combination Cement Concrete Curbing and Gutter," complete in place, which prices shall include all materials, forms, equipment, tools, labor and work incidental thereto, and shall include all excavation and backfilling.

Payment will be made under,

Item 115. Plain Cement Concrete Gutter, (per square yard).

Item 116. Combination Cement Concrete Curbing and Gutter, (per linear foot).

ITEM 117. REPAVED STONE GUTTER

ITEM 118. REPAVED BRICK GUTTER

117.01 Description: Repaved gutters shall consist of the removal and clearing of the existing bricks, blocks or stone, the adjusting of the subgrade of foundation, if for a rubble or similar stone gutter, or the placing of a new bed for a brick or block gutter, and the placing of a new filler. This work shall be done in accordance with these specifications.

117.02 Materials: All existing bricks, blocks or stones which are acceptable shall be used.

The materials for the foundation, bed and filler shall meet the requirements of similar materials specified for the same kind or similar kind of new gutter.

117.03 Construction Methods: The existing gutter shall be removed, the unacceptable material disposed of in a satisfactory manner and the acceptable material handled carefully and piled neatly. Bricks, blocks or stones from the existing gutter shall be cleaned thoroughly before being again used. The repaving shall be done in accordance with the specifications contained herein for new gutters of the same or similar kind as that relaid, care being taken to turn the good face of used bricks up.

117.04 Method of Measurement: The item of repaved stone gutters or repaved brick gutter, as the case may be, will be measured by the square yard, complete in place.

117.05 Basis of Payment: This work will be paid for at the contract unit price per square yard for "Repaved Stone Gutters" or "Repaved Brick Gutters", as the case may be, complete in place, which price shall include all materials necessary to complete the work in a satisfactory manner and all equipment, tools, labor, and work incidental thereto, also the satisfactory disposal of surplus material.

Any whole sections of new gutter in excess of one (1) square yard will be paid for at the contract unit price per square yard of new gutter for the kind laid.

Payment will be made under,

Item 117. Repaved Stone Gutter, (per square yard) complete in place.

Item 118. Repaved Brick Gutter, (per square yard) complete in place.

ITEM 119. RESET CURBING

ITEM 120. RESET, COMBINATION CURBING AND GUTTER

119.01 Description: This work shall consist of the digging up, moving, and resetting or the readjustment and resetting of the existing curbing or combination curbing and gutter to the lines and grades given, and in accordance with the specifications.

119.02 Materials: All existing curbing or combination curbing and gutter which is acceptable shall be used, however no curbing or combination curbing and gutter less than four (4) feet in length shall be used. All joints in the curbing or combination curbing and gutter, from the base to the top shall be painted and filled with a bituminous filler, meeting the requirements of any one of Paragraphs 36.17, 36.18, 36.19, or 36.20 of Pamphlet "G", and of a thickness as directed by the Engineer.

119.03 Construction Methods: The existing curbing or combination curbing and gutter shall be dug up, cleaned, and readjusted in a satisfactory manner upon the prepared subgrade. The curbing or combination curbing and gutter shall be set accurately to the line and grade given. When unsatisfactory material is encountered in the preparation of the subgrade, it shall be removed and replaced with suitable material which shall be tamped in layers of not more than six (6) inches in depth to secure a firm, unyielding foundation. After the curbing or the combination curbing and gutter has been set and the joints filled, it shall be backed with suitable material which shall be tamped firm. Sections of curbing or combination curbing and gutter not suitable for resetting, may be cut and used for constructing headers at street intersections.

119.04 Method of Measurement: This item will be measured by the linear foot of reset curbing or reset combination curbing and gutter as the case may be, complete in place.

119.05 Basis of Payment: This work will be paid for at the contract unit price per linear foot for, "Reset Curbing" or "Reset Combination Curbing and Gutter", as the case may be, complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, also the necessary excavation, refilling and the satisfactory disposal of surplus material.

Payment will be made under,

Item 119. Reset Curbing, (per linear foot) complete in place.

Item 120. Reset Combination Curbing and Gutter, (per linear foot) complete in place.

ITEM 121. STONE UNDERDRAINS

121.01 Description: This underdrain shall consist of a trench having a minimum depth of thirty (30) inches, eighteen (18) inches wide at the bottom with flaring sides, filled with large stones to a depth of fifteen (15) inches, so as to produce voids through which water will drain; the upper portion of the trench to be filled with earth. It shall be constructed in accordance with the plans and in conformity with these specifications.

121.02 Materials: The bottom course shall consist of approved, sound, hard, durable, rough slabs of stone from eight (8) to ten (10) inches in depth, from one (1) to three (3) inches in width, and of a length greater than the depth. The top course shall consist of sound, hard, durable slabs of stone from one (1) to three (3) inches in thickness. If sufficient local material of the above quality is not available for top course stone, there may be substituted wholly or in part, approved, clean, crushed rock or gravel, that will pass a three (3) and be retained on a one (1) inch sieve.

121.03 Construction Methods: Where indicated or directed by the Engineer, the Contractor shall excavate a trench eighteen (18) inches wide at the bottom and of the required depth, with sides battered outward one (1) inch in twelve (12) inches. The bottom of the trench shall be finished to the grade given, it shall be smooth and firm, and tamped if necessary. The bottom course stone shall be set carefully by hand, longitudinally with the trench, in vertical position, side by side, so as to give maximum voids. The vertical joints between the ends of bottom course stone shall be staggered, and the bottom course shall be from eight (8) to ten (10) inches in depth. The top course stone shall be placed over the bottom course to fill the trench to a total depth of fifteen (15) inches. The slabs shall be laid flat over the bottom course stone, to cover it as completely as practicable, and up to the fifteen (15) inch line, with joints close and staggered and necessary voids filled carefully with stone, or gravel. The remainder of the trench above the fifteen (15) inch line shall be filled with suitable earth, which shall be compacted thoroughly by tamping four (4) inch layers. Suitable outlets shall be provided and protected with endwalls or small dry stone box openings.

121.04 Method of Measurement: This item will be measured by the linear foot, complete in place.

121.05 Basis of Payment: This work shall be paid for at the contract unit price per linear foot for "Stone Underdrain", complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, also the excavation of all classes of material encountered, and the refilling and satisfactory disposal of all surplus material. Where stone box outlets are used, they shall be paid for as "Stone Underdrain."

ITEM 122. SHOULDER DRAINS

122.01 Description: This shoulder drain shall consist of a trench cut to a depth of one (1) foot below sub-grade, eighteen (18) inches wide at the bottom with flaring sides, filled with shell, gravel, crushed limestone, slag, or other suitable material acceptable to the Engineer, and the refilling of the trench.

122.02 Construction Methods: Where indicated on the plans or directed by the Engineer, the Contractor shall excavate a trench eighteen (18) inches wide at the bottom, and of the required depth with sides battered outward one (1) inch in one (1) foot. The bottom of the trench to be finished to the grade given, shall be smooth and firm, and tamped if necessary. The material to be used shall be placed in the trench so as to give the maximum voids. After the material has been placed in the trench, in acceptable manner, the trench shall then be filled with earth, and left in workmanlike manner.

122.03 Method of Measurement: This item will be measured by the linear foot, complete in place.

122.04 Basis of Payment: This work will be paid for at the contract unit price per linear foot for "Shoulder Drains", complete in place, which price shall include all materials, tools, labor and work incidental thereto, also the excavation of the trench, and the refill and the satisfactory disposal of any waste material.

STEEL FABRIC OR MESH REINFORCEMENT FOR BRIDGES

123.01 Materials: Fabric reinforcement shall be furnished in flat sheets. The Contractor shall at all times have on hand a sufficient supply of reinforcement cut and straightened for not less than one (1) day's work. The maximum widths of sheets shall be nine (9) feet. This style of reinforcement shall be fabricated from steel manufactured by either the Bessemer or Open Hearth process, and the wire cold drawn from rods, hot rolled from billets.

The wire after fabrication shall have a minimum tensile strength of seventy thousand (70,000) pounds per square inch, and shall withstand being bent cold, around its own diameter, through one hundred and eighty (180) degrees, without cracking on the outside of the bent portion.

Fabricated reinforcement shall consist of members securely fastened at all joints, or points of intersection, and so constructed that the sheet will retain its original shape during the necessary handling. The effective cross-sectional area of metal in the main members of the fabric shall be not less than ninety-three thousandths (.093) of a square inch per foot of length of pavement, and the secondary members shall be not less than forty-seven thousandths (.047) of a square inch per foot of width of pavement. The main members shall be spaced not less than four (4) nor more than eight (8) inches apart and the secondary members shall be spaced not more than sixteen (16) inches apart.

123.02 Placing Reinforcements: The concrete shall be roughly struck off, by means of a template, two (2) inches below the proposed finished surface before the reinforcing is placed. The sheets or mats of reinforcement shall be immediately placed two (2) inches below and parallel to the finished surface, unless otherwise

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indicated on the plans, or as directed, with the main members laid at right angles to the center line of the pavement or at such an angle as is considered most advantageous for the kind of fabric used. Immediately thereafter the remainder of the concrete shall be placed and finished by the prescribed method. The sheets of reinforcement shall extend to within two and one-half ($2\frac{1}{2}$) inches of both ends and sides of the slabs, or sections, except as otherwise specified. The outer main members of adjacent sheets of reinforcement shall be lapped past each other not less than one-half ($\frac{1}{2}$) their minimum spacing when the lap is made at right angles to the center of the pavement. In pavements of unusual width, and when sheets of reinforcement are permitted to be lapped parallel to the center line, the lap shall be made not less than twelve (12) inches.

123.03 Basis of Payment: The contract price for fabric or mesh reinforcement shall include all labor, material, transportation and minor items necessary for the proper completion of the work. Payment will be made on a pound price under item No. 123 Steel Fabric Reinforcement.

ITEM 125. SALVAGED GRAVEL

125.01 Description: This item shall consist of the scarifying of the gravel on the abandoned road, the hauling, placing and spreading of same on the new road, as directed by the Engineer and in conformity with these specifications.

125.02 Construction Methods: The old gravel road shall be scarified thoroughly, care being taken not to scarify below the depth of the gravel. It shall then be bladed into one or more windrows, placed in trucks or wagons and hauled up to one (1) mile, dumped, spread, harrowed, shaped, machined, and all other work necessary to properly perform the work, as directed by the Engineer.

125.03 Overhaul on Salvaged Gravel: A "Quarter-mile cubic yard" is a cubic yard of material overhauled one-fourth ($\frac{1}{4}$) of a mile. The length of overhaul shall be the distance from the point of origin of the material to the point of placement, measured along the shortest practicable route, less one (1) mile.

125.04 Basis of Payment: This work will be paid for at the contract unit price per cubic yard for "Salvaged Gravel", complete in place, which price shall include scarifying, hauling not more than one (1) mile, laying, spreading, and reshaping, all equipment, tools, labor and work incidental thereto.

Hauling material beyond the first mile shall be paid for at the contract price per quarter-mile-cubic yard for "Overhaul on Salvaged Gravel".

Payment will be made under,

Item 125. Salvaged Gravel, (per cubic yard) complete in place.

Item 125-A. Overhaul on Salvaged Gravel, (per quarter-mile-cubic yard).

ITEM 130. REMOVAL OF EXISTING CULVERTS

130.01 Description: This item shall consist of the removal of existing concrete culverts, as indicated on the summary sheet of drainage structures, and the satisfactory disposal of the removed materials.

130.02 Basis of Payment: This work will be paid for at the contract unit price per culvert under Item 130, "Removal of Existing Culverts", which price shall include all equipment, tools, labor and work incidental thereto.

ITEM 134. REBUILT GUARD RAIL

134.01 Description: This item shall consist of taking down and rebuilding existing guard rail, as indicated on the plans or as directed by the Engineer. The Contractor shall take every possible precaution and care against damage in removing and replacing of this guard rail.

134.02 Basis of Payment: This work will be paid for at the contract unit price per linear foot for "Rebuilt Guard Rail", which price shall include all equipment, tools, labor and work incidental thereto.

ITEM 135. REMOVAL OF EXISTING BRIDGES

135.01 Description: This item shall consist of the removal of existing bridges and abutments, as indicated on the summary sheet of drainage structures, and the satisfactory disposal of the removed materials.

135.02 Basis of Payment: This work will be paid for at the contract unit price per bridge under Item 135, "Removal of Existing Bridges", which price shall include all equipment, tools, labor and work incidental thereto.

ITEM 141. REMOVAL AND RELOCATION OF BUILDINGS, STRUCTURES, ETC.

The work involved under the Item "Removal and Relocation of Buildings, Structures, etc." consists of the removal of the buildings, structures, etc., from the right-of-way required for the construction of this project and the relocation of the buildings, structures, etc., in their new positions, including the replacement of foundation piers, chimneys, concrete floors, etc. Where concrete floors are to be replaced in the buildings the price bid for the removal of the buildings shall also include the breaking up of the existing concrete floor and the disposal of same. Where filling stations are to be removed, the unit price bid for the removal of same shall include the removal and relocation of all pumps, tanks, pipes, etc., in connection with the building. This work will be paid for at the contract unit price bid for each building, structure, etc., removed and relocated, as listed in the proposal, which price shall include all materials, equipment, tools, labor and work incidental thereto.

The Contractor will be responsible for all damage or injury to buildings, structures, etc., by or on account of the moving of same, or due to neglect or omission on his part, and shall restore at his expense such damage or injury as may be sustained. In case of the failure on the part of the Contractor to restore such property or make good such damage, the Engineer may, upon written notice, proceed to repair and restore all such damage and the cost thereof will be deducted from any moneys due, or which may become due the Contractor under this contract.

The Contractor will be required to furnish the Commission with a certificate of release from each property owner, stating that the building, structure, etc., removed and relocated, is in an acceptable condition and that he waives all claim for damages to such building, structure, etc., removed.

The Contractor shall begin the removal of buildings, structures, etc., on that portion of the road designated by the Engineer and shall maintain a force on the work sufficient to satisfactorily do the work.

The distance of buildings, structures, etc., to be moved back of the right-of-way of the highway will not be more than 100 feet.

GENERAL SPECIAL PROVISIONS

The following general special provisions shall apply to individual projects when the special provisions of the projects refer to paragraphs under these general special provisions.

1. Precaution Against Fire: The Contractor's attention is called to the fact that the Commission has received a communication from the Louisiana Conservation Commission to the effect that Contractors will be held responsible for damage to forests or other property caused by fires emanating from the Contractor's camps or from materials being burned along the right-of-way, and that all such cases will be prosecuted according to law.

2. All things being equal, materials manufactured in the State, also products of the State, such as sand, gravel, crushed stone, etc., shall be used in all State contracts.

3. Revisions in Specifications Pamphlet "A" of February, 1929: On page 25 under "Partial Payments", change the last sentence in the first paragraph to read: "Progress estimates shall be based on material in place and labor expended thereon, but not more than 85% 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". Change paragraph two to read as follows: "The amount of said estimate, after deducting fifteen (15) percent and all previous payments, shall be due and payable to the Contractor at the office of the Treasurer of the State of Louisiana". The above changes have been made in accordance with Act No. 63, passed by the Legislature of the State of Louisiana at the Regular Session of 1930.

4. Upon completion of work required under this contract 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 remaining in place, whether new or old. The clearing shall be thoroughly done to the satisfaction of the Engineer and all materials removed accordingly shall be deposited on the downstream side of the structure. No direct payment will be made for this work and the cost of same should be included in the prices bid on other items.

5. The Contractor will be required to provide for and maintain local traffic at all times during the construction of that portion of this project where the improvement is along the existing travelled road. The cost of this work shall be included in the prices bid on other pay items.

6. The Contractor will be required to provide for and maintain local and through traffic at all times during the construction of that portion of this project where the improvement is along the existing travelled road. The cost of this work shall be included in the prices bid on other pay items.

7. The Contractor shall provide and maintain satisfactory detours around the structures or suitable or adequate temporary bridges over the structures to be rebuilt or extended, where the improvement is along the existing traveled road. No direct payment will be made for this work and the cost should be included in the prices bid on other pay items.

8. The cost of removing headwalls of existing culverts or pipes, where structures are to be lengthened, as indicated on the plans, shall be included in the price bid on concrete, under Item 61, and other pay items. No direct payment will be made for removal of culvert pipe headwalls where pipes are to be removed.

9. Where existing concrete culverts are to be removed the structure shall be completely removed down to the floor and no part of the walls or wings shall be left in place.

10. The excavation of material from under existing bridges, where indicated on the plans or required by the Engineer, shall be classed as "Drainage Excavation" and paid for as such.

11. The Contractor will be required to raise or lower, as conditions require, all manholes, manhole covers and valve boxes on this project over which pavement is to be laid, adjusting them to fit the finished grade of the pavement. Payment for this work shall be included in the unit price bid per square yard for concrete pavement.

12. All vehicles for hauling local surfacing materials shall be accurately measured and the volume plainly marked on the sides of the vehicle. No changes will be made in the size or capacity of the body of the vehicle without notifying the Engineer. The material shall be so loaded that the quantity can be readily determined. No payment shall be made for partially loaded vehicles and no additional payment will be made for overloaded vehicles.

13. The unit prices bid on "excavation" and "borrow" shall include all clearing and grubbing to properly construct the project.

14. **Revision in Pamphlet "N" of December, 1929, Paragraph 81.30, "Painting":** Eliminate the words, "one ounce of lampblack" from the formula.

15. **Creosoted Lumber:** Creosoted lumber shall be surfaced four sides except bulkhead, wingwall and sway bracing planks, which shall be rough lumber.