

**Standard Specifications  
for Construction Work  
on the Secondary  
Road System**

**SERIES OF 1948  
IOWA STATE HIGHWAY COMMISSION  
AMES, IOWA**



Standard Specifications  
for  
Construction Work  
on the  
Secondary Road  
System

January 1948

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These specifications are standard for all construction work on the secondary system and are issued to supplement and interpret the plans prepared in accordance therewith. These specifications represent minimum requirements.

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## PART I

### DIVISION 11, GENERAL REQUIREMENTS AND COVENANTS

This part consists of the general provisions applying to all types of construction and maintenance as set forth in the following sections.

- Section 1101. Definitions.
- Section 1102. Proposal Requirements and Conditions.
- Section 1103. Award and Execution of Contract.
- Section 1104. Scope of Work.
- Section 1105. Control of Work.
- Section 1106. Control of Materials.
- Section 1107. Legal Relations and Responsibility to the Public.
- Section 1108. Prosecution and Progress.
- Section 1109. Measurement and Payment.

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#### Section 1101. Definitions

**1101.01 DEFINITION OF TERMS.** In these specifications and the contract of which they are a part, the following definitions shall obtain:

**A. A. S. H. O.** The American Association of State Highway Officials.

**Auditor.** The Auditor of the Contracting County duly elected under Chapter 39 of Code of Iowa 1946.

**A. S. T. M.** The American Society for Testing Materials.

**Backslope.** The sloping surface of a cut, borrow pit or ditch of which the downward inclination is toward the traveled way.

**Bidder.** Any person, firm or corporation submitting a written proposal in answer to an advertisement or request for bids for the construction of the contemplated improvement or any portion thereof.

**Board or County Board.** The County Board of Supervisors as constituted under Chapter 39 of Code of Iowa 1946.

**Bridges.** Waterway structures having a clear span in excess of 12 feet.

**Classes of Work.** The divisions made for the purpose of measuring and paying for labor to be performed or materials to be furnished according to the methods of construction in-



**Right of Way.** The land area which is reserved or secured by the County, for constructing the work or for obtaining material therefor.

**Roadbed.** The area between the inside slopes of ditches or tops of fill slopes.

**Roadway.** That portion of the right of way included between the outside lines of the slopes, gutters and side ditches of the proposed improvement.

**Shoulders.** That part of the roadbed not occupied by the traveled way or pavement.

**Skew Angle.** The angular deviation of the axis of a culvert or bridge from a true right angular crossing of a road. It is the complement of the angle of crossing.

**Special Provisions.** Clauses or memoranda not herein contained, applying to the contract of which these specifications are a part, and changing or supplementing these specifications.

**Specifications.** The requirements contained herein and in any special provisions applying to the contract, and pertaining to the method and manner of performing the work, or to the quantity and quality of the materials to be furnished under the contract.

**State.** The State of Iowa.

**Station.** One hundred lineal feet.

**Subcontractor.** Any person, firm or corporation who has, with the approval of the County, contracted with the Contractor to execute and perform in his stead, all or any part of the contract of which these specifications are a part.

**Subgrade.** The portion of the roadbed upon which the surface course or pavement is to be placed.

**Substructure.** All that part of a bridge below the bridge seats or below the skew-back of arches. Backwalls, wingwalls and wing protection railings shall be considered as part of the substructure.

**Subway.** A structure, with its approaches, which provides for highway traffic to pass without interruption under a railway or another highway.

**Superintendent.** The Contractor's authorized representative in responsible charge of the work.

**Superstructure.** All that part of a bridge above the bridge seats or above the skew-back of arches, except that defined as substructure.



**Supplemental Agreements.** Written agreements between the Contractor and County Board, modifying the original contract.

**Surety.** The corporate body other than the Contractor signing the contract bond.

**Temporary Structure.** Any structure required to maintain traffic during construction of the work and which will be dismantled when the work is completed. The temporary structure shall include the earth approaches thereto.

**Work (The Work).** The materials and operations necessary for the construction of the specified improvement, as indicated on the plans or as set forth in the contract.

## **Section 1102. Proposal Requirements and Conditions**

**1102.01 CONTENTS OF PROPOSAL FORM.** Bidders will be furnished with proposal forms showing the location and description of the contemplated work, the approximate quantities of work to be performed or materials to be furnished, the form and amount of the required proposal guaranty, and the contract period. The proposal form will also contain a reference to any special provisions or requirements which are supplemental to the standard specifications. Proposals shall be prepared as required by the proposal form and the specifications.

**1102.02 ESTIMATE OF QUANTITIES.** For all work let on a unit price basis the Engineer's estimate of quantities as shown in the notice to bidders and proposal is understood to be approximate only, and will be used only for comparing bids, except as otherwise provided in the basis of payment for the various classes of work. No material change in quantities shall be made by increasing or decreasing the length of road or roads to be improved as shown by the plans and described in the proposal form, unless the Contractor gives his written consent to such increase or decrease.

**1102.03 EXAMINATION OF PLANS, SPECIFICATIONS, SPECIAL PROVISIONS AND SITE OF WORK.** It is the responsibility of the bidder to examine the plans, specifications, special provisions and the site of the work to make sure that the requirements are fully understood. Bidders must satisfy themselves as to the nature of the work and all conditions affecting the performance of the contract.

**1102.04 PREPARATION OF PROPOSALS.** Only signed proposals, submitted on forms furnished by the County will be considered, and the bidder will be assumed to have



familiarized himself with the requirements of any and all special provisions by reference made a part of these specifications. To insure consideration, all blank spaces in the proposal form must be filled in correctly and amounts written legibly. Any unauthorized changes in, or additions to, the proposal form will be considered sufficient grounds for its rejection by the County Board.

If the proposal is made by a partnership or corporation, the name of the partnership or corporation, its agent and its principal place of business shall be shown.

**1102.05 PROPOSAL GUARANTY.** Each proposal shall be supported by a proposal guaranty in the form and amount prescribed in the notice to bidders. Bids not so supported will not be read.

A certified check, to be acceptable, shall be drawn on a solvent bank, and shall bear an endorsement, signed by a responsible official of such bank, as to the amount certified.

**1102.06 FILING OF PROPOSAL.** The proposal and the supporting proposal guaranty for each project shall be filed in separate but attached envelopes, so marked as to indicate their contents. All proposals shall be filed with the Auditor at the place designated in the notice to bidders, prior to the time advertised for the opening of bids.

**1102.07 WITHDRAWAL OF PROPOSAL.** A bidder will be given permission to withdraw his proposal unopened, if such request is made in writing to the County Board prior to the time specified in the advertisement for the opening of proposals. No proposals may be withdrawn after the time specified for opening.

**1102.08 PUBLIC OPENING OF PROPOSALS.** Proposals will be publicly opened and read at the time and place stipulated in the notice to bidders.

**1102.09 COMPETENCY OF BIDDEES.** Before receiving a contract award, bidders will be required to make such a showing as will satisfy the County Board that they are capable of performing the various items of work. As a part of such showing, bidders will be required to furnish the County Board a detailed statement of construction experience, a list of the machinery, plant and other equipment which they propose to use on the work, and such statement of their financial resources as the County Board may require. The necessary forms and in-



structions for furnishing such statement will be supplied by the County Board upon application.

**1102.10 FOREIGN CORPORATIONS.** Before entering into a contract involving construction or maintenance work, corporations organized under the laws of any other state shall file with the Commission a certificate from the Secretary of the State of Iowa, showing that they have complied with all of the provisions of Chapter 494 of the Code of Iowa, 1946, governing foreign corporations. For contracts involving only the furnishing of materials the foregoing requirement does not apply.

### Section 1103. Award and Execution of Contract.

**1103.01 CONSIDERATION OF BIDS.** The County Board reserves the right to waive technicalities and to reject any or all proposals. Bidders may be denied a contract award for any one of the following reasons:

- (a) For failure to meet the County Boards requirements for the qualification of bidders, as set forth in Articles 1102.09 and 1102.10 and in the special provisions for the project.
- (b) For failure to maintain satisfactory progress on work already under contract (Article 1108.02).
- (c) For failure to meet promptly the financial obligations undertaken in connection with other work under contract.
- (d) For filing more than one proposal at any letting for the same work under the same or different names.
- (e) For an unsatisfactory record of performance and cooperation on previous contracts.

**1103.02. AWARD OF CONTRACT.** In the award of contracts, consideration will be given not only to the prices bid but also to the mechanical and other equipment available to the bidder, the financial responsibility of the bidder, and his ability and experience in the performance of like or similar contracts.

Award of contracts will be made as promptly as practical after bids have been opened and read. The County Board reserves the right to delay the award for such time as is needed for the consideration of the bids, and for the receipt of concurrence in recommended contract awards from other governmental agencies whose concurrence may be required.



**1103.03 RETURN OF PROPOSAL GUARANTY.** Proposal guarantees will be returned to the unsuccessful bidders promptly after the award has been made. If a bidder does not have a representative present when proposal guarantees are returned, his guaranty will be returned by registered mail to the address given in the proposal.

**1103.04 REQUIREMENT OF CONTRACT BOND.** On all contracts amounting to \$1000.00 or more the Contractor shall file with the County Auditor an acceptable bond in an amount not less than 75 per cent of the contract sum. The bond shall be executed in triplicate on the standard form of the Commission, which bond shall be held to cover all the work included in the contract, whether performed by the Contractor or under a subcontract or assignment. The bond shall be executed by the Contractor and by a surety company authorized to do business in the State of Iowa.

**1103.05 EXECUTION OF CONTRACT.** The bidder to whom a contract has been awarded shall execute and file three copies of such contract with the Auditor within fifteen days after the award has been made.

**1103.06 FAILURE TO EXECUTE CONTRACT.** Failure to execute a contract and file an acceptable bond within fifteen days of the date of the contract award, as herein provided, shall be just and sufficient cause for the annulment of the award, and for forfeiture of the proposal guaranty to the County in liquidation of damages sustained.

### Section 1104. Scope of Work.

**1104.01 INTENT OF PLANS AND SPECIFICATIONS.** The intent of the plans and specifications is to provide for the construction and completion of every detail of the work described therein. It is understood that the Contractor for all or any part of the work will furnish all labor, material, tools, transportation and supplies required to make each item complete in accordance with the contract.

**1104.02 SPECIAL WORK.** Any conditions not covered by these standard specifications are stated in the special provisions.

**1104.03 INCREASED OR DECREASED QUANTITIES.** The County Board reserves the right to make such increase or de-



crease in the quantities of the work shown on the plans as may be considered necessary to complete fully and satisfactorily the construction included in the contract. The compensation to the Contractor for such changes will be as provided in Article 1109.04.

**1104.04 EXTRA WORK.** The County Board reserves the right to order the performance of work of a class not contemplated in the proposal but which may be considered necessary to complete satisfactorily the work included in the contract. Such extra work shall be paid for as provided in Article 1109.04.

**1104.05 MAINTENANCE OF DETOURS.** Unless so required by the plans or the special provisions, the Contractor will not be required to assume any responsibility in connection with the maintenance or marking of suitable detours.

**1104.06 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS.** The Contractor for bridge and culvert work shall remove any existing structure or part of structure that in any way interferes with the new construction. If specific payment for such work has not been provided in the contract, it will be paid for as extra work.

The Contractor for road work shall remove any materials or structures found on the right of way which are not to remain in place or which have not been designated for use in the new construction. The removal of pipe culverts and the disposition of same will not be paid for directly but shall be considered as incidental work; and the cost of such removal and disposal shall be considered to be included in the contract price for other items. The removal and disposition of bridges or other masonry or monolithic concrete construction will be paid for. If the contract does not contain an item for such work, it will be paid for as extra work.

**1104.07 RIGHTS IN AND USE OF MATERIALS FOUND ON THE RIGHT OF WAY.** Unless stated to the contrary in the contract documents, all materials, such as stone, gravel, sand, timber, and structures or parts of structures, found on the right of way of the highway or on land acquired for the work, are the property of the County, or of the owner of the fee title to the land, and shall not be used or destroyed by the Contractor without special permission from the Engineer. When the Contractor is permitted to use material found on the right of way, any excavations that he makes below the grade



elevations shall be backfilled with other suitable materials so that the finished road will conform to the grade shown on the plans. No extra compensation will be allowed for such backfilling.

**1104.08 FINAL CLEANING UP.** Before final acceptance of the work the Contractor shall remove all unused material and rubbish from the site of the work, remedy any objectionable conditions that he may have created on private property, and leave the right of way in a clean and presentable condition.

**1104.09 RIGHT OF WAY AND RAILROAD CROSSINGS.** Right of way for the road will be provided without cost to the Contractor, and it is contemplated that all of the needed right of way will have been acquired before the work is placed under contract. Whenever it is necessary to secure additional right of way, performance of the work affected thereby is contingent upon the securing of such right of way. No claims will be allowed for loss or damage occasioned by delays in securing right of way.

Whenever the work involves construction with which railroad companies are concerned, the performance of the work is contingent upon arrangements with the railroad companies for the proposed construction. No claims will be allowed for loss or damage caused by failure to complete such arrangements.

**1104.10 PUBLIC UTILITIES.** The owners or operators of public utilities shall have access to the work for the installation or adjustment of service connections. No compensation shall be allowed because of delay or interference caused by such work. All frames of openings for valves, manholes, catch basins or other fixtures encountered in areas to be covered by a pavement, shall be adjusted to the proper elevation before the pavement is placed. Payment for such adjustment will be as provided in Paragraph 2301.35F.

## Section 1105. Control of Work.

**1105.01 AUTHORITY OF ENGINEER.** The Engineer will have general supervision of the work, and will decide any questions that arise with reference to the intent of the contract documents and compliance therewith. He will pass on all questions relating to materials, work, progress, disputes and mutual rights between contractors, fulfillment of contract and compensation, in accordance with the provisions of these specifications.



**1105.02 PLANS.** The official plans, profiles and cross-sections on file in the office of the Auditor show the location, typical construction details and dimensions of the work contemplated. The work is to be performed in conformity therewith except in case of error or unforeseen contingency.

The plans are made up from careful surveys, and represent the foreseen construction requirements. Any deviation from the plans made necessary by the exigencies of construction, or because of error, will be determined by the Engineer, and if necessary, corrected or modified drawings will be provided.

**1105.03 WORKING DRAWINGS.** Bridge Work. General drawings showing such details as are necessary to give a comprehensive idea of the construction that is contemplated, will be furnished to prospective bidders. The Contractor shall submit to the Engineer for approval three copies of the detailed shop drawings of all structural steel work and false-work plans, and other detailed drawings, as required by these specifications. Such drawings shall be approved by the State Highway Commission. Prior to the approval of such plans, any work done or material ordered shall be at the Contractor's risk.

Shop drawings for steel structures shall give full detailed dimensions and sizes of all component parts of the structure, and details of all miscellaneous parts, such as pins, nuts, bolts, rivets, drains, etc.

It is expressly understood that the approval of the working drawings submitted by the Contractor covers the requirements for strength and detail, and the County assumes no responsibility for errors in dimensions.

**1105.04 CONFORMITY WITH PLANS.** No deviation from plans will be permitted the Contractor without the Engineer's written approval and authorization.

**1105.05 COORDINATION OF SPECIFICATIONS, PLANS AND SPECIAL PROVISIONS.** In case of any discrepancy between the drawings and the figures written thereon, the figures are to be taken as correct; and in case of any discrepancy between the drawings and specifications, the drawings are to govern. In case of a discrepancy between the general specifications and special provisions, or between the drawings and the Special Provisions, the Special Provisions shall govern.

The Contractor shall not take advantage of any apparent error or omission in the plans or specifications, or of any discrepancy between the plans and specifications. The Engineer



shall be permitted to make such correction and interpretation as may be deemed necessary for the fulfillment of the intent of the plans and specifications, subject to compensation as provided in Articles 1109.03, 1109.04 and 1109.05. Written notice of changes in plans shall be given the Contractor by the Engineer.

**1105.06 SUPERVISION BY CONTRACTOR.** The Contractor shall at all times have a competent authorized representative on the work who shall have authority to take any action necessary for the fulfillment of the contract in accordance with the contract documents. A copy of the official plans and specifications shall be available on the work at all times.

**1105.07 CONSTRUCTION STAKES.** The Engineer shall set the necessary centerline, slope and grade stakes promptly upon notification by the Contractor that stakes are needed.

For all structures, the Engineer shall set stakes for roadway centerline and such other stakes as are necessary to establish definitely the location, elevation and alignment of the structure. If so requested by the Contractor, the Engineer shall furnish stakes determining the centerline of piers or pedestals, the face of abutments, and angles of the wings or retaining walls. When such stakes or lines are given by the Engineer, the County shall be responsible for the correctness thereof.

The County shall not be responsible for delays due to lack of grade or line stakes unless the Contractor shall have given the Engineer twenty-four hours' written notice that such stakes will be needed, and unless his work is being conducted in a satisfactory manner and at the specified rate of progress.

The Contractor shall be held responsible for the preservation of stakes and marks, and if, in the opinion of the Engineer, any of the survey stakes or marks have been carelessly or wilfully destroyed or disturbed by the Contractor, the cost of replacing them shall be charged against him and deducted from the payment for the work.

**1105.08 AUTHORITY AND DUTIES OF INSPECTOR.** The County Board may appoint inspectors to inspect all materials used and all work done under the contract. Such inspection may extend to any part of the work and to the preparation or manufacture of the materials to be used. The Inspector will not be permitted to modify in any way the provisions of the contract documents, nor to delay the work by failing to inspect



materials and work with reasonable promptness. An inspector is placed on the work to keep the Engineer informed as to its progress and the manner, in which it is being done; also, to call the Contractor's attention to any infringements of the contract documents. The Inspector shall not act as foreman or perform other duties for the Contractor, nor improperly interfere with the management of the work. He will not be authorized to approve or accept any portion of the work. In case of dispute between the Contractor and Inspector as to quality of materials or the manner of performing the work, the Inspector shall have authority to reject materials or suspend the work until the question at issue can be decided by the Engineer. Written notice of the suspension of work shall be given to the Engineer and the Contractor.

**1105.09 INSPECTION.** The Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether the work is being performed in conformance with the contract documents. At any time before acceptance of the work, upon request of the Engineer, the Contractor, shall remove or uncover such portions of the finished work as the Engineer may direct. After examination has been made, the Contractor shall restore such portions of the work to the standard required by the contract documents.

If the work thus exposed or examined proves acceptable, the uncovering or removing and replacing of the covering, or the restoring of the parts removed, shall be paid for as extra work, except that no payment shall be made for the work involved in checking the smoothness of concrete surfaces. If the work thus exposed and examined proves unacceptable, the Contractor shall replace the defective work in accordance with the specifications, and shall be paid only the contract price for the work as finally accepted. Work done or materials used without suitable supervision or inspection by the Engineer may be ordered removed and replaced at the Contractor's expense.

**1105.10 REMOVAL OF DEFECTIVE WORK.** Any defective work shall be removed and replaced at the Contractor's expense.

Should the Contractor fail or refuse to remove defective work when so ordered by the Engineer, the Engineer shall have authority to order the Contractor to suspend further operations, and may withhold payment on estimates until such defective work has been removed and replaced in accordance with the plans and specifications. Continued failure or refusal on the



jected by the Engineer even though it may previously have been accepted. Stored materials shall be so located as to facilitate thorough inspection.

**1106.04 DEFECTIVE MATERIALS.** Materials which do not meet the requirements of these specifications will be rejected, and shall be promptly removed from the work.

### Section 1107. Legal Relations and Responsibility to the Public

**1107.01 LAWS TO BE OBSERVED.** The Contractor is presumed to be familiar with all laws, ordinances and regulations that may in any manner affect those engaged or employed upon the work, or the materials or equipment used in or upon the work, or that may in any way affect the conduct of the work. The Contractor shall so conduct the work that conflict with any such laws, ordinances or regulations will be avoided and he shall save harmless the County and its representatives against any claim arising from violation thereof.

The Contractor shall give preference to Iowa domestic labor, in accordance with the provisions of Chapter 73, Code of Iowa 1946, and this provision is hereby specifically made a part of any contract of which these specifications are a part. A person shall be deemed a domestic laborer of this State if he is a citizen and has resided in this State for more than six months.

**1107.02 LIABILITY INSURANCE.** It shall be the Contractor's responsibility to see that all of the construction operations incident to the completion of his contract are covered by liability insurance in order that the general public or any representative of the County may have recourse against a responsible party for injuries or damages sustained as a result of said construction operations. This requirement shall apply with equal force, whether the work is performed by (1) persons employed directly by the Contractor, (2) by a subcontractor or his employees, or (3) by an independent contractor.

The liability insurance shall be written by an insurance company (or companies) qualified to do business in Iowa. The minimum coverage provided by such insurance shall be

Public Liability Insurance—

\$10,000 per person

\$20,000 per accident



**Property Damage Insurance—**

\$ 5,000 per accident

Failure on the part of the Contractor to comply with the requirements of this article will be considered sufficient cause to shut down the work, withhold estimates, and to disqualify him from receiving further contract awards.

**1107.03 PERMITS AND LICENSES.** The Contractor shall procure all necessary permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

**1107.04 PATENTED DEVICES, MATERIALS AND PROCESSES.** The Contractor shall indemnify and save harmless the County against all claims for infringement of patents, or for royalty on tools, machinery, appliances, devices or materials used in the construction and completion of the work except such as are specifically required by the contract documents.

The County assumes responsibility for the payment of claims for damages for patent or copyright infringement or for royalties on material, processes, specifications or types of construction that are required by the contract documents.

**1107.05 RESTORATION OF SURFACES OPENED BY PERMIT.** If, prior to final acceptance, any repairs to the roadway constructed hereunder are made necessary by the construction or repair of drains or sewers, the laying or repairing of pipes or conduits for telegraph or electric wires, or from any other disturbance of the said roadway under permission issued by the County Board, the Contractor shall, upon notification by the Engineer, immediately make the necessary repairs in conformity with the specifications. Such repairs shall be paid for as extra work unless such repairs are made necessary by the negligence or carelessness of the Contractor, in which event no extra compensation will be allowed.

The Contractor shall not authorize any person or persons to make an opening in the roadway unless a permit, duly authorized by the County, is presented.

**1107.06 SANITARY PROVISIONS.** The Contractor shall provide for his employees the necessary sanitary convenience, properly secluded, and shall observe all rules and regulations of the state and local health officials and take such precautions as are necessary to avoid creating unsanitary conditions.

**1107.07 PUBLIC CONVENIENCE AND SAFETY.** During the progress of the work the Contractor shall make provision



for the convenience of the traveling public and the residents along the improvement, and claims for extra expense incurred by reason thereof shall be considered as provided in Article 1109.04.

Whenever it is possible to do so, and a suitable road is available for detour, the County will close the portion of the road under construction, and cause suitable detour signs to be erected marking such detour. If no detour for traffic is to be provided by the County, the plans or special provisions will so indicate. The Contractor is not required to maintain detour roads, nor the approaches to temporary bridges, unless his contract so provides.

Materials stored upon the highway shall be so placed as to cause the minimum obstruction to traffic. On highways occupied by railroad tracks, the Contractor shall provide and maintain temporary platforms for the entrance and exit of passengers to and from railway cars. Sidewalks, gutters, sewer inlets and portions of the highways adjoining the roadway under construction shall not be obstructed more than is absolutely necessary.

**1107.08 BARRICADES AND WARNING SIGNS.** The Contractor shall provide and maintain barricades, danger and warning signs, and suitable and efficient lights, and shall take every precaution to prevent accidents. The Contractor shall provide, at his own expense, such watchmen as are necessary to protect his equipment and to maintain proper lights. Watchmen that may be necessary to direct traffic or prevent travel on any portion of the roadway shall be provided by the Contractor on written order from the Engineer. Unless the contract specifically provides that such watchmen are to be furnished by the Contractor, this expense shall be paid for as provided in Article 1109.04.

Where the road is under his control the Contractor will be held responsible for any damage to the newly completed portions of the work resulting from traffic permitted by his negligence.

**1107.09 USE OF EXPLOSIVES.** When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property, and whenever so directed, the number and size of the charges shall be reduced to insure greater safety. All explosives shall be stored in a secure manner, and storage places shall be clearly marked "Danger--Explosives".



The Contractor's attention is called to existing Federal regulations regarding the use of explosives.

**1107.10 PROTECTION AND RESTORATION OF PROPERTY.** The Contractor shall replace or renew fences, sidewalks or other property damaged by reason of his work or the negligence of his employees. He shall take suitable precautions to prevent damage to telephone, telegraph and electric transmission lines along the highway; to pipes, conduits and other underground structures, and shall carefully protect from disturbance all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location, and he shall not remove them until so directed. He shall be responsible for all damage or injury to property resulting from the prosecution of the work, except that his responsibility shall not extend to damage to fences, telephone, telegraph or electric lines occupying the right-of-way unlawfully, provided due caution has been used in removing them. The Contractor's responsibility shall not be released until the work under his contract shall have been completed and accepted.

**1107.11 RESPONSIBILITY FOR DAMAGE CLAIMS.** The Contractor shall indemnify and save harmless the County and all its officers or agents, from claims or liability of any character, arising out of any acts or omissions, neglect or misconduct on the part of the Contractor or his employees.

Responsibility of the Contractor for all damages or injuries to the traveling public on any portion of the road covered by his contract shall not cease until the work on such portion has been released by the Engineer. "Release by the Engineer" shall be construed to mean a written statement by the Engineer to the effect that the Contractor may cease to maintain barriers and red lights, that the road may be opened to traffic, and that the Contractor is relieved of further maintenance of that portion of the road. Such "Release by the Engineer" shall not constitute an acceptance of the work.

The Contractor's responsibility for the maintenance of lights and barriers on any individual structure shall cease upon final acceptance of such structure, or when specifically released in writing by the Engineer.

**1107.12 OPENING OF SECTION OF HIGHWAY TO TRAFFIC.** The Contractor shall not be responsible for damages to portions of the road which have been released by the Engineer and opened to traffic prior to final approval and acceptance



**1108.04 METHODS AND EQUIPMENT.** The methods, equipment and appliances used shall produce a satisfactory quality of work, and shall be adequate to maintain the schedule of progress specified.

If at any time the equipment, appliances or methods employed on the work are such that the quality of the finished work is not satisfactory, or the specified rate of progress is not being maintained, the Contractor shall make such changes in the equipment or appliances, or furnish such new equipment or appliances, or adopt such methods as will insure a satisfactory finished product within the contract period.

Permission given by the Engineer to use any particular methods, equipment or appliances shall not be construed:

- (a) To relieve the Contractor from furnishing other equipment or appliances, or adopting other methods for the prosecution of the work at any time that it appears necessary to do so in order to produce work complying with the specifications.
- (b) To bind the County to accept work which when completed does not conform to the requirements of the contract.

**1108.05 CHARACTER OF WORKMEN.** Any employee of the Contractor who is careless, incompetent or disorderly, or refuses or neglects to perform his work in accordance with the specifications, or who shall commit trespass upon any public or private property in the vicinity of the work, shall be discharged upon the written request of the Engineer, and shall not be reemployed on any of the work unless written permission is given by the Engineer.

**1108.06 TEMPORARY SUSPENSION OF WORK.** Work shall be suspended wholly or in part when, in the opinion of the Engineer, weather or other conditions are unfavorable to its satisfactory prosecution. Work shall also be suspended at the direction of the Engineer pending settlement of disputes arising out of failure of the Contractor to comply with the provisions of the contract. Written notice of suspension of work shall be given by the Engineer.

**1108.07 EXTENSION OF CONTRACT PERIOD.** An extension of the contract period may be granted by the County Board for any of the following reasons:

- (a) Additional work resulting from a modification of the plans for the project.



- (b) Delays caused by the County.
- (c) Other reasons beyond the control of the Contractor which in the County Board's judgment, would justify such extension.

No extension of contract period will be allowed for variations between contract quantities and actual quantities which cannot be predetermined and which amount to less than 20 per cent of the contract quantities.

**1108.08 FAILURE TO COMPLETE WORK WITHIN CONTRACT PERIOD.** If the Contractor fails to complete his work within the contract period, or any extension thereof as provided in Article 1108.07, said contract shall, without further action or notice, be in default. The County Board may, at its option, permit the Contractor or his surety to complete the work included in the contract, or may proceed to complete the work in accordance with the provisions of Article 1108.10. In either event, the Contractor or his surety shall be responsible for all costs incident to the completion of the work, and also for the liquidated damages stipulated in the proposal form. The County Board may waive such portion of the liquidated damages as may accrue after the work is in condition for the safe and convenient use by the traveling public.

**1108.09 CONTRACTS IN DEFAULT.** The County Board may declare a contract in default for any one of the following reasons:

- (a) Failure to complete the work within the contract period or any extension thereof.
- (b) Failure or refusal to comply with an order of the Engineer within a reasonable time.
- (c) Failure or refusal to remove rejected materials.
- (d) Failure or refusal to perform anew any defective or unacceptable work.
- (e) Bankruptcy or insolvency, or the making of an assignment for the benefit of creditors.
- (f) Failure to carry on the work in an acceptable manner.

**1108.10 COMPLETION OF CONTRACTS IN DEFAULT.** If for any reason a contract is declared in default, the County Board shall have the right, without process or action at law, to take over all or any portion of the work and complete it at its option, either by day labor or by reletting same. Written notice shall be given the Contractor by the County Board that his contract has been declared in default, and upon receiving



such notice, the Contractor shall peaceably relinquish possession of the said work or the parts thereof specified in the notice.

The County Board may, at its option and at a rental which it considers reasonable, retain all material, equipment and tools on the work until the work has been completed.

Neither the County or any Member of the Board or employee thereof shall be in any way liable or accountable to the Contractor or his surety for the method by which the completion of the said work, or any portion thereof, may be accomplished or for the price paid therefor. Should the cost of completing the work be in excess of the original contract price, the Contractor and his surety shall be held responsible for such excess cost. Should the cost of such completion, including all proper charges, be less than the original contract price, the amount so saved shall be paid to the Contractor. Neither by taking over the work nor by declaring the contract default shall the County forfeit the right to recover damages from the Contractor or his surety for failure to complete his entire contract.

**1108.11 TERMINATION OF CONTRACTOR'S RESPONSIBILITY.** The contract shall be considered completed when the work has been accepted in writing by the County Board. Such acceptance shall release the Contractor from all further obligation with respect thereto, except as to conditions and requirements set forth in his bond.

### Section 1109. Measurement and Payment

**1109.01 MEASUREMENT OF QUANTITIES.** The work completed under the contract shall be measured according to United States Standard measures. Payment will be based on the actual quantity of work performed under the different classifications of work in the contract, except as otherwise specifically provided in the method of measurement for various classes of work.

When the contract has been completed without material changes in the plans, the Contractor and the County Board may enter into written agreement that final settlement will be based on contract quantities without remeasurement.

**1109.02 SCOPE OF PAYMENT.** The Contractor shall accept the compensation herein provided as full payment for furnishing all materials, labor, tools and equipment and for performing all work under the contract; also for all costs arising from



the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the work and up to the time of the acceptance thereof, except damages to the work due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor.

**1109.03 ADJUSTMENT IN CONTRACT PRICE.** When the measured quantity of any item of work varies by more than 20 percent from the estimated quantity specified in the contract, an adjustment in price may be made for such item of work. Such adjustment may be requested by either party to the contract.

If the increase or decrease in quantity is due to a change in plans or specifications, any price adjustment shall be requested and agreed upon before the work is done. If the increase or decrease in quantity is not the result of a change in plans or specifications, but results from errors in original estimates or unforeseen conditions, price adjustments may be requested after the work is completed.

In making price adjustments consideration shall be given to the portion of the cost of the work that can be classified as fixed costs, independent of the exact quantity of work performed, such as transportation and installation costs on equipment, overhead costs, etc. Any price adjustment shall be arrived at from the standpoint that neither party to the contract shall be penalized by the increase or decrease in quantities which occasioned the price adjustment.

All price adjustments shall be agreed to by the County Engineer and the Contractor and shall be subject to the approval of the County Board.

**1109.04 PAYMENT FOR WORK PERFORMED.** The Contractor will receive and accept payment for work performed under his contract, as follows:

- A. Items of work performed which are covered by definite prices stipulated in the contract. For all items of work performed which are covered by definite unit prices or lump sum amounts specified in the contract, the Contractor shall receive and accept compensation at the rate specified in the contract, except as provided in Article 1109.03.
- B. **Extra work.** Extra work ordered by the Engineer, of a quality or class not covered by the contract, will be paid for at either an agreed price or on a force account basis.



1. **Agreed Price Basis:** For extra work ordered by the Engineer and performed on an agreed price basis, the Engineer and the Contractor shall enter into a written agreement before such work is undertaken. This written agreement shall describe the extra work that is to be done, and shall specify the agreed price or prices therefor.
2. **Force Account Basis:** Extra work performed on a force account basis will be paid for in the following manner: For laborers, teams, timekeepers, foremen and superintendents the Contractor shall receive the rate of wage shown on previous payrolls for the time they are actually engaged in the extra work, to which shall be added an amount equal to 25 percent thereof, plus the amount of social security tax imposed by law upon the Contractor because of such force account work, plus the cost of workmen's compensation and public liability insurance. The 25 percent shall cover compensation for the furnishing of the necessary small tools for the work together with all other overhead items of expense. The wages of the superintendent, timekeeper or foreman who is employed partly on force account work and partly on other work shall be prorated between the two classes of work according to the number of men shown by the payrolls as employed on each class of work.

For materials used on force account work the Contractor shall receive the actual cost of the materials delivered on the work, including freight and hauling charges as shown by original receipted bills, to which cost shall be added a sum equal to 15 percent thereof.

For machinery, tools or equipment, and fuel and lubricants therefor, except small hand tools which may be used, the Engineer shall allow the Contractor a reasonable rental at a rate to be agreed upon in writing before such work is begun. No profit percentage shall be added to the rental.

Compensation as herein provided shall be accepted by the Contractor as payment in full for extra work done on a force account basis, and shall include the use of tools and equipment for which no rental is allowed, overhead and profit.

At the end of each day the Contractor shall prepare



payrolls in duplicate for labor furnished on a force account basis, using the County's standard force account forms. Both copies shall be signed by the Inspector and the Contractor's representative. One copy shall be furnished to the Engineer and one to the Contractor. Claims for extra work performed on a force account basis shall be submitted to the Engineer in triplicate. To the claims shall be attached such receipts or statements as the Engineer may require in support of such claims. Such claims shall be filed not later than the tenth day of the month following that in which the work was actually performed, and shall include all labor charges, rental charges on machinery, tools and equipment, and all material charges insofar as they are available.

**1109.05 CANCELED WORK.** When unforeseen difficulties prevent or unreasonably delay the completion of the contract, or of certain items included therein, the County Board shall have the right to cancel any or all of such items. For the finished portions of items canceled the Contractor will be paid at the contract unit prices, in accordance with the provisions of Article 1109.04.

For materials ordered and delivered for the unfinished portion of such canceled or omitted items, the County will pay cost plus 5 percent as an overhead charge. The Contractor's expense for work of handling or transporting such material shall be included in computing the cost.

The County will also pay any actual expenses sustained by the Contractor by reason of such cancellation or omission and not represented by work completed or material delivered. In computation of material costs or expenses sustained, no anticipated profit will be included. Material paid for shall become the property of the County and shall be disposed of as directed by the Engineer.

**1109.06 PARTIAL PAYMENTS.** If the work extends over a period of more than one month, the Contractor will receive monthly estimates based on the amount of work completed in an acceptable manner. On contracts for which the contract sum is Ten Thousand Dollars (\$10,000.00) or more, monthly estimates may be allowed on materials of acceptable quality which have been delivered on the work and stored in a manner satisfactory to the Engineer. The Engineer's monthly estimates are partial payments on the contract sum, and the al-



**1109.12 TIME LIMITS FOR FINAL ADJUSTMENT.** It is understood that the County shall not be bound to consider applications for correction of estimates and payments after the Contractor has signed his final estimate, or after 30 days from the date when the final estimate is submitted to the Contractor for his approval.



## PART II

### CONSTRUCTION DETAILS

#### DIVISION 21. EARTHWORK OR GRADING

This work shall consist of that commonly referred to as grading and shall include the various items and operations described and specified in the following sections:

- 2101. Clearing and Grubbing.
- 2102. Roadway and Borrow Excavation.
- 2103. Roadway and Borrow Excavation—Station Measurement.
- 2104. Channel Excavation.
- 2105. Stripping, Salvaging and Spreading Top Soil.
- 2106. Embankments.
- 2107. Overhaul.
- 2108. Soil Aggregate Sub-base.
- 2109. Natural Subgrade.
- 2110. Shoulders for Pavement.

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#### Section 2101. Clearing and Grubbing

2101.01 DESCRIPTION. Except for trees and shrubs to be preserved as indicated on the plans or designated by the Engineer, all trees, brush, shrubs, stumps, logs, weeds, corn stalks, other herbaceous vegetation and all rubbish shall be removed from the right-of-way and from borrow pits furnished by the County. This work shall be classified as follows:

- A. Clearing shall consist of the cutting and removal of all trees having diameters 3 inches or more measured at a height 18 inches above the ground.
- B. Grubbing shall consist of the removal of stumps 3 inches or more in diameter and large roots.
- C. Hedge removal shall consist of the pulling or grubbing and disposing of hedge fences of osage orange or other shrubs planted close together in rows. If any individual tree of those composing a hedge has a diameter greater than 6 inches it shall be measured separately as a tree.
- D. Brush removal shall consist of pulling or grubbing and disposing of trees or shrubs less than 3 inches in diameter and not classified as hedge.



E. Weed and rubbish removal shall consist of the removal and disposal of weeds, grass, corn stalks, other herbaceous vegetation and all rubbish encountered on the work.

**2101.02 CONSTRUCTION.** Unless otherwise shown on the plans or ordered by the Engineer, the entire area to be covered by embankment shall be cleared and grubbed. In the disposal of trees, hedges and shrubs removed, the contractor shall respect the rights of the fee owner of the land to the materials thus obtained. All timber saved at the request of the land owner and stored within view of the roadway at his request, shall be trimmed and piled in neat piles. All stumps, roots, brush, weeds and rubbish and all trees or parts of trees not saved as provided above shall be burned or otherwise disposed of as directed by the Engineer.

**2101.03 METHOD OF MEASUREMENT.** The Engineer will measure all trees at a height 18 inches above the ground. The diameter will be determined by measuring the circumference to the nearest inch and dividing by 3.14. The diameter of stumps shall be the average diameter measured at cut-off.

The quantity of hedge rows removed shall be measured in hundreds of lineal feet.

The area from which brush is removed shall be measured in squares of 100 square feet.

**2101.04 BASIS OF PAYMENT.** Payment for clearing and grubbing and the removal of hedge and brush, measured as provided above, shall be made in accordance with the following schedule, except that when so provided in the contract this work may be paid for at a stipulated percentage of this schedule:

A. Clearing and Grubbing.

Size—Diameter	Clearing	Grubbing	Clearing and Grubbing
3 in. to 6 in. inclusive	\$ 0.25	\$ 0.55	\$ 0.80
Over 6 in. to 9 in. inclusive	0.55	1.40	1.95
Over 9 in. to 12 in. inclusive	0.95	2.40	3.35
Over 12 in. to 15 in. inclusive	1.40	3.30	4.70
Over 15 in. to 18 in. inclusive	2.35	4.40	6.75
Over 18 in. to 24 in. inclusive	3.50	5.60	9.10
Over 24 in. to 30 in. inclusive	4.75	7.00	11.75
Over 30 in. to 36 in. inclusive	6.15	8.85	15.00
Over 36 in. to 42 in. inclusive	7.50	12.50	20.00
Over 42 in. to 48 in. inclusive	10.00	17.50	27.50
Over 48 in. to 60 in. inclusive	15.00	22.50	37.50
Over 60 in.	18.75	25.00	43.75



- B. Removal and Disposal of Logs or Down Timber—One-half the price for clearing.
- C. Hedge Removal—\$12.00 per 100 feet.
- D. Brush Removal—\$0.20 per square of 100 square feet.
- E. Removal of Growing Corn (July 1 to October 1)—\$0.20 per 100 square feet.
- F. Weed Removal—The removal and disposal of weeds, grass, corn stalks and other herbaceous vegetation shall not be paid for directly but shall be included in the contract unit prices for excavation.

The estimated cost for clearing and grubbing, computed in accordance with the provisions of this section, shall be shown in the contract and included in the contract sum.

## Section 2102. Roadway and Borrow Excavation

**2102.01 DESCRIPTION.** This work shall include the removal of all materials as indicated on the detailed roadway plans and from borrow pits exclusive of that designated as channel excavation. It shall also include the removal of material necessary to provide suitable approaches from intersecting highways and private entrances. It shall include all the shaping and sloping necessary for the construction of the roadbed, slopes, gutters, inlet and outlet ditches in conformity with the alignment grade and cross sections shown on the plans and with these specifications.

The Contractor will be required to work around pole lines without extra compensation.

**2102.02 CLASSIFICATION OF EXCAVATION.** All roadway and borrow excavation will be classified as Class 10, Class 10A, Class 12 or Class 13 as hereinafter defined and as indicated in the contract.

Class 10 excavation shall include all normal earth materials such as loam, silt, gumbo, peat, clay, soft shale, sand or gravel. It shall include fragmentary rock or boulders handled in the manner normal to this class of excavation. It shall include any combination of the above described materials and any other material not classified as Class 12.

When specifically stated in the Special Provisions that portion of excavation which would otherwise be classified as Class 10 excavation and on which no end haul will be required, will be classified as Class 10A Side Cast Excavation. No excavation



will be classified as Class 10A except when specifically so provided in the Special Provisions. Excavation will be classed as Class 10A Side Cast Excavation only, when at least 25% of the excavation in any one mile can be included in this class and when each of the various sections to be placed in this class is 500 feet or more in length and when such sections are clearly marked on the plans or described in the proposals.

Class 12 excavation shall include the actual measured volume of granite, trap, quartzite, chert, limestone, sandstone, hard shale or slate in natural ledges or displaced masses. It shall also include the estimated or measured volume of rock fragments or boulders which occur on the surface or in subsurface deposits mixed with earth, sand or gravel when their size, number or location prevents them from being handled in a manner normal to Class 10 excavation.

Class 13 excavation shall include all materials included under the definitions of Class 10 and 12 and any other material encountered regardless of its nature. The various materials encountered in Class 13 excavation shall be used or disposed of as herein provided for the various kinds of material but no separate measurements of such various classes of materials will be made. This classification covers the kind of work commonly referred to as "Unclassified Excavation". When Class 13 excavation is specified none of the excavation involved shall be classified as Class 10 or Class 12.

#### 2102.03 REMOVAL AND DISPOSAL OF BOULDERS.

Boulders encountered in excavation shall be removed or buried. Surface collections of boulders within the limits of the work in the form of stone walls, windrows in fence lines or other assembled heaps shall be removed where necessary for the satisfactory completion of the work. After the completion of excavation operations and as a part of the finishing process the Contractor shall collect all loose boulders, rocks and pieces of broken concrete that show up during the finishing operation. Boulders shall be disposed of in one or more of the following ways.

- A. Boulders too large to be loaded and hauled conveniently may, at the Contractor's option, be buried near the spot at which they occur. Care shall be taken that boulders so buried are covered with at least one foot of earth.
- B. Boulders or rock fragments may be used in the construction of embankments if such use does not interfere with the specified compaction of the embankment, provided



they are covered with at least one foot of earth. If boulders delivered to embankment in combination with finer material interfere with compaction they shall be removed and disposed of as provided in Paragraph D of this article.

- C. If the quantity of boulders or rock fragments available at any one time is more than 100 cubic yards, such material may be placed in the embankment not less than two feet below the finished grade line in accordance with the provisions of Article 2106.05, except that they shall be covered with at least two feet of earth on slopes.
- D. Boulders not disposed of as provided above will be used for filling gullies or will be ricked in neat compact piles at points within the right of way accessible from the traveled way.

Boulders except those handled in a way normal to Class 10 excavation, will be classified as Class 12 excavation. Excavation made for the purpose of burying boulders will not be measured or paid for.

**2102.04 REMOVAL OF UNSTABLE SOILS.** Where excavation to the finished grade line leaves a subgrade of unstable soil, the Engineer may require the Contractor to remove the unstable material and backfill to the finished grade with satisfactory material.

The Contractor shall conduct his operations in such a way that the Engineer is given opportunity to take cross sectional measurements required before the backfill is placed.

The Engineer may designate as unstable soils, materials encountered above the elevation of the finished subgrade, if the soil is of such nature that it cannot be properly consolidated in embankments. All unstable material shall be disposed of as specified in Article 2106.07.

If the plans show locations where unstable soils are to be removed and replaced the work shall be done in accordance with the following provisions:

- A. The unstable soil shall be removed to the elevation shown on the plans and shall be disposed of as indicated on the plans or as directed by the Engineer. The areas thus excavated shall be backfilled with the material called for on the plans.



close as possible to construction operations, and on roads that must be kept open to traffic during construction, adequate provision shall be made for the safety and convenience of the traveling public. If the Contractor fails to maintain partly finished work in a satisfactory manner, construction shall be discontinued if so ordered in writing by the Engineer, until all finishing and maintenance work is in satisfactory condition. Before final acceptance, the roadway shall be finished for travel substantially true to line, grade and cross section.

The degree of finish for grading slopes, shoulders and ditches shall be that ordinarily obtainable through the use of suitable power equipment operating under favorable conditions and operated by skilled workmen. Hand methods of finishing will be required only in the event that satisfactory results are not otherwise obtained.

**2102.11 GRADING FOR PAVING.** The following requirements shall apply to contracts for grading work to be done in conjunction with paving work covered by a contract separate from the contract for the pavement.

The grading contractor shall build the rough grade to the full width of the roadbed and with sufficient crown to provide surface drainage. Within the area between lines one foot outside the edges of the proposed pavement and within any 100 foot station length the average surface elevation of the rough grade shall not be lower than the average elevation of the pavement subgrade and shall not be above this elevation by more than 0.2 foot.

If surplus material intended for later use in the construction of shoulders is deposited within the limits of the roadbed such material shall be so placed and distributed as to offer no serious interference to the construction and finishing of the pavement. Sufficient openings shall be provided through such material to provide for adequate drainage to side ditches.

**2102.12 METHOD OF MEASUREMENT.** The Engineer will determine the quantity of Class 10, Class 10A, Class 12 or Class 13 material excavated from the roadway, from borrow pits and from drainage channels, other than intercepting ditches and flumes. Except as hereinafter provided, measurements will be made by cross sectioning the area excavated before and after excavation. Volumes will be computed in cubic yards from the cross section measurements by the average end area method.

If both Class 10A Side Cast Excavation and Class 10 excavation is specified in the same project, the amount of Class 10,



excavation, will be determined as follows: Shrinkage factors will be determined by dividing the project into suitable sections having similar soil conditions, measuring both cuts and embankments, and finding the ratio that exists between excavation and embankment quantities. Between any stations containing both Class 10A, Side-Cast Excavation, and Class 10, Excavation, the surplus of excavation over embankment quantities will be classified as Class 10, earth excavation, after the proper shrinkage factor, determined as herein provided, has been applied.

The volume of top soil stripped and salvaged as provided in Section 2105 will be excluded from quantities measured as provided above.

Boulders or rock fragments classified as Class 12 excavation will be measured as follows:

Boulders buried near the site where they occur will be measured individually.

Boulders or rock fragments deposited in heaps or piles will be measured by the cubical contents of the heap or pile.

Boulders or rock fragments handled separately from fine material and placed in embankments or in gullies will be measured in the transporting vehicle.

Boulders or rock fragments mixed with earth, sand, gravel or other fine material and which cannot be handled in a way normal to Class 10 excavation will be measured in the following manner: The total volume of the mixture of rock and finer material will be determined by cross sectional measurements if practical. Otherwise it will be estimated by the Engineer. This volume will be multiplied by the estimated percentage of solid particles larger than four inches in their largest dimension. The quantity thus determined will be considered as Class 12 excavation. The remainder will be considered as Class 10 excavation.

Boulders handled and deposited in final position in a manner normal to Class 10 excavation will not be measured as Class 12 excavation.

The length of intercepting ditches and flumes will be measured in feet along their centerlines.

Selected backfill material consisting of soil in its natural condition shall be measured in excavation.

Selected backfill material consisting of material reclaimed from the surface of an old road shall be measured in embankment. To the measured volume shall be added 30 percent to compensate for all shrinkage that may occur during compaction.



Special backfill material shall be measured in tons of material placed except that if measurement by weight is impractical the material may be measured by volume in the transporting vehicle and this volume converted to tons by assuming that one cubic yard of material weighs 3000 pounds.

The removal of pipe culverts and disposal of same will not be measured for payment.

**2102.13 BASIS OF PAYMENT.** The quantity of roadway and borrow excavation measured as provided above shall be paid for at the contract prices per cubic yard for Class 10, Class 10A, Class 12 and Class 13 excavation, which prices shall be full compensation for excavating, loading, transporting within the free haul limit and depositing the excavated material in the manner prescribed in these specifications; the preparation of the site for embankments and the formation and compaction of embankments; the finishing of the earth roadway, side ditches and slopes; repairing and replacing of all fences that have been unnecessarily damaged or removed by the Contractor; and such incidental work as may be required to make the grading work complete. Payment will not be made for excavation work done prior to the staking and cross sectioning of the work by the engineer.

When the contract contains a separate unit price for below grade excavation all excavation made below grade in accordance with the plans or the order of the Engineer will be paid for at the contract price for such excavation.

When the contract does not contain a separate unit price for below grade excavation but the plans indicate that such excavation is to be made and included in the total quantity of roadway and borrow excavation, the quantity of below grade excavation made in accordance with the plans will be paid for at the contract unit price for the class of excavation involved.

When the contract does not contain a price for below grade excavation and the plans do not indicate that below grade excavation will be required, such excavation ordered by the Engineer shall be paid for at double the contract price in the case of Class 10 excavation and at the contract price in the case of Class 12 or Class 13 excavation.

When the contract contains a price for Class 10 excavation only and the plans do not indicate that Class 12 materials are to be expected, any necessary Class 12 excavation, either above or below grade, will be paid for at ten times the contract unit price for Class 10 excavation.



Excavation for intercepting ditches and flumes for the removal of surface water from sidehill cuts into side ditches shall be paid for at the contract price per lineal foot for such ditches and flumes.

Selected backfill shall be paid for at the contract price per cubic yard.

Special backfill shall be paid for at the contract price per ton.

Excavation for run-out ditches to divert the flow of water from side ditches away from the toe of embankments will be paid for at the contract unit price for Class 10, Class 12 or Class 13 excavation as the case may be.

The removal of pipe culverts and disposal of same will not be paid for directly but shall be considered as work incidental to excavation.

### Section 2103. Roadway and Borrow Excavation— Station Measurement

**2103.01 DESCRIPTION.** Work contracted under the provisions of this section will consist primarily of side borrow excavation. It shall comprise the same work as that specified under section 2102, except as to method of measurement and basis of payment and that the plans may show only an approximate grade line and typical cross sections. Except as modified by this section or by notations on the plans, the provisions of section 2102 and other sections having reference to roadway excavation and embankment shall apply to work performed under the provisions of this section. All haul required shall be considered as incidental to the work, and not subject to measurement or payment.

**2103.02 CLASSIFICATION.** All excavation shall be classified as Class 13 excavation.

**2103.03 METHOD OF MEASUREMENT.** The Engineer shall compute in stations of 100 lineal feet the length of roadway constructed from measurements along the centerline of the completed roadway.

The Engineer shall determine the number of lineal feet of roadway culverts of various sizes and types installed by measuring along the flow line of the culverts.

**2103.04 BASIS OF PAYMENT.** For the number of stations of roadway constructed, measured as provided above, the contractor shall be paid the contract price per station.



For the number of lineal feet of roadway culverts installed, measured as provided above, the contractor shall be paid the contract price per lineal foot. Such payment shall be full compensation for furnishing the material for the culverts and for their installation, including any excavation necessary for such installation.

### Section 2104. Channel Excavation

**2104.01 DESCRIPTION.** This work shall consist of the removal of material incidental to channel changes outside the limits of the detailed roadway cross sections shown on the plans, and the disposal of the excavated material as shown on the plans, or as directed by the Engineer.

**2104.02 CLASSIFICATION.** Channel excavation shall be classified as provided in Article 2102.02.

**2104.03 METHOD OF MEASUREMENT.** The quantity to be paid for will be the cubic yards measured in the excavation, as prescribed in Article 2102.12.

**2104.04 BASIS OF PAYMENT.** The quantity of excavation performed, classified and measured as prescribed above, shall be paid for at the contract unit price or prices per cubic yard for "Channel Excavation," which prices shall be full compensation for excavating and disposing of the material within the free haul limit of 1,000 feet, and furnishing all equipment, tools, labor and incidentals necessary to complete the work except for excavation underneath bridge spans. Where the clearance of the bridge structure above the original ground line on the center line of the channel is 12 feet or more, the excavation will be paid for at the contract unit prices. Where the above mentioned clearance is less than 12 feet the excavation underneath the bridge structure and within 10 feet on each side of the extreme width of span, measured at the center of span at right angles to the center line of the roadway, will be paid for at double the contract price for channel excavation.

### Section 2105. Stripping, Salvaging and Spreading Top Soil

**2105.01 DESCRIPTION.** This item shall consist of removing top soil from borrow pits, cuts or areas to be covered by embankments; the preparation of sod; the hauling, depositing and spreading the top soil on shoulders, slopes, excavated areas,



borrow pits and other designated areas, in conformity with the plans and these specifications.

**2105.02 PREPARATION OF SOD.** All weeds, grass and growing crops or other herbaceous vegetation shall be mowed close to the ground and burned or disposed of as directed by the Engineer. Sod shall be shredded by shallow plowing or blading and thorough discing. The shredding shall be sufficiently thorough to permit the soil to be easily spread in a thin layer over areas to be covered.

**2105.03 EXCAVATION OF TOP SOIL.** After any sod present has been prepared the top soil shall be removed to the depth specified by the Engineer. The top soil may be moved directly to an area where it is to be used and be spread over that area. Where this method of handling is impractical or would result in unnecessary overhaul, the material will be placed in stock piles to be spread later.

**2105.04 PLACING TOP SOIL.** The top soil shall be spread uniformly over the area to be covered. The surface of the top soil shall be smoothed and left in a finished condition so that it will drain properly.

**2105.05 METHOD OF MEASUREMENT.** The number of cubic yards of top soil moved will be determined by measuring it in place, either in stock piles constructed as directed by the Engineer or spread over areas designated to be covered. In cases where the method of handling top soil is such as to preclude the taking of final cross sectional measurements before the top soil is placed over an excavated area, the Engineer shall determine the average depth of top soil placed and shall make corresponding corrections in quantities computed from cross sectional measurements taken on the finished work. Top soil salvaged from excavated areas and paid for as top soil will not be included in excavation quantities for which payment is made.

**2105.06 BASIS OF PAYMENT.** For the stripping and salvaging of top soil measured as specified above, the Contractor shall be paid the contract price per cubic yard for stripping and salvaging top soil. This price shall be full compensation for preparing, stripping, transporting and placing the top soil in accordance with the plans and these specifications.



**2106.05 ROCK FILLS.** When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the thickness prescribed above without crushing, pulverizing or further breaking down the pieces resulting from the excavation methods, such material may be placed in the embankment in horizontal layers not exceeding 4 feet in thickness. Each layer shall be leveled and smoothed with suitable dozer and by distribution of spalls and finer fragments or earth over the surface.

The 4-foot lifts shall not be constructed above an elevation 2 feet below the finished grade line. The next foot of height of embankment may be placed in one layer using rock spalls and finer fragments which may be satisfactorily consolidated by the dozer and tractor. The last foot below the finished grade line shall be composed of suitable earth smoothed and placed in layers not exceeding 6 inches in loose thickness and rolled as hereinbefore specified. The Contractor shall conduct his operations in such a way that the Engineer is given opportunity to take any cross sectional measurement required before the earth cover is placed.

**2106.06 REBUILDING EMBANKMENTS.** A rigid pavement shall not be placed partly on an old and partly on a newly constructed embankment. If the width or position of the existing roadbed is such as to cause it to create the condition described above, the part of the old embankment which would otherwise be beneath the pavement shall be removed to the natural ground line or to a depth of 5 feet below the proposed finished grade line, whichever is the less, and rebuilt as prescribed for new embankments.

**2106.07 DISPOSAL OF UNSTABLE SOILS.** Unstable soils shall not be used in embankments except with the specific permission of the Engineer. The use of such soil shall be avoided in that portion of the embankment bounded by the plane of the finished grade, a plane 5 feet below that plane and the planes making 1 to 1 slopes outward from the proposed shoulder lines. When used in embankments, the unstable material shall be spread in uniform layers not more than 3 inches thick and each layer shall be covered with a layer or layers of stable material.

**2106.08 EMBANKMENTS ADJACENT TO CULVERTS AND BRIDGES.** All embankments placed adjacent to bridges or culverts shall be placed in accordance with the provisions



of the section applying to the construction of the specific type of structure involved and in conformity with the provisions of Articles 2402.08 and 2402.09.

**2106.09 METHOD OF MEASUREMENT.** The construction of embankments will not be measured separately for payment except as follows:

- A. Rebuilding embankments. Removal of existing embankments as specified in Article 2106.06 shall be measured as provided in Article 2102.12.
- B. Water required to be used for moistening materials placed in embankments shall be measured in thousands of gallons by gauging the contents of transporting vehicles or by metering the supply.

**2106.10 BASIS OF PAYMENT.** The work of building embankments will not be paid for directly, but shall be considered as subsidiary work pertaining to excavation or borrow and included in the contract unit prices therefor.

Excavations made necessary in the rebuilding of embankments as provided in Article 2106.06 shall be paid for in accordance with the provisions of Article 2102.13. Water required to be used for moistening materials placed in embankments shall be paid for at the contract unit price per thousand gallons if such contract unit price is provided. If no such contract price exists this water shall be paid for as extra work as provided in Paragraph 1109.04-B.

### Section 2107. Overhaul

**2107.01 DESCRIPTION.** Overhaul shall consist of the transportation of excavated material from roadway and borrow excavation, from channel excavation, and from excavation for structures over a distance in excess of the free haul limit specified for the particular kind of excavation involved.

**2107.02 METHOD OF MEASUREMENT.** In determining what constitutes necessary haul, it will be assumed that material taken from excavation will be deposited in adjacent embankment after having been hauled the minimum possible distance. The haul distance for material moved from outside the roadway shall be measured along the shortest route determined by the Engineer to be feasible and satisfactory. The haul distance for material obtained from the roadway and placed inside the roadway shall be measured along the centerline of the roadway.



The limits of free haul shall be determined from a mass diagram by fixing on the volume curve, two points, one on each side of the neutral grade point, one in excavation and the other in embankment; such that the distance between them equals the free haul distance, and the included quantity of excavation and embankment balance. All materials within this free haul limit shall be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment minus the free haul distance shall be the overhaul distance. The quantity of overhaul shall be the product of the overhaul distance in stations of 100 feet multiplied by the number of cubic yards of material hauled a distance greater than the free haul distance. Unless otherwise provided in the contract documents, the free haul distance shall be 1,000 feet.

**2107.03 BASIS OF PAYMENT.** The quantity of overhaul measured as provided above shall be paid for at 1 cent per station yard with the following exceptions:

No overhaul will be paid for selected backfill material if it can be secured and used as shown on the plans. Should changes from the plans cause an increase in the necessary haul, overhaul will be paid on such increase at 1 cent per station yard.

Overhaul for all classes of excavation for structures, except Class 24 shall be paid for at 5 cents per station yard. Overhaul on Class 24 excavation shall be paid for at 1 cent per station yard.

No overhaul will be paid for excavation to which the provisions of Section 2103 apply.

### Section 2108. Soil-Aggregate Sub-Base

**2108.01 DESCRIPTION.** The construction of soil-aggregate sub-base shall consist of the addition of granular material to the material in the existing roadbed, the mixing of these two materials, the shaping and consolidation of the mixture in advance of the preparation for the placement of a base course, surface course or pavement.

**2108.02 MATERIAL.** The granular material used shall be sand, gravel or crushed stone which when tested by means of laboratory sieves, shall conform to the following requirements:



Passing a 2½-inch sieve .....	100%
Passing a No. 4 sieve .....	65 to 100%
Passing a No. 10 sieve .....	50 to 100%
Passing a No. 200 sieve .....	0 to 10%

**2108.03 CONSTRUCTION.** The width and thickness of soil-aggregate sub-base to be built shall be that shown on the plans. The area to be occupied by the sub-base shall be brought to an elevation such that the surface of the sub-base will be at the required elevation.

The surface of the grade thus prepared shall be scarified uniformly to the depth necessary to provide the quantity of existing subgrade material required in the sub-base. The scarified material shall be pulverized to such a degree that it contains no soil particles larger than one inch. The granular material shall be uniformly distributed at the rate shown on the plans. The soil and granular material shall be thoroughly mixed, and the mixture shall be brought uniformly to the moisture content which will insure maximum compaction.

The mixture shall then be spread and shaped in such a way that when compacted the sub-base will have the required cross section. The sub-base shall then be compacted by means of a tamping type roller to a degree of density not less than 95 per cent of maximum density.

**2108.04 METHOD OF MEASUREMENT.** The Engineer shall determine the miles of soil-aggregate sub-base constructed by measuring the length along the centerline of the sub-base. At intersections the length of sub-base measured for payment shall not include that portion of centerline which overlaps previously constructed or previously measured pavement base course or sub-base. Granular material furnished for the construction of soil-aggregate sub-base shall be measured in tons of 2,000 pounds dry weight as weighed on scales provided by the Contractor and corrected for the weight of moisture contained.

**2108.05 BASIS OF PAYMENT.** For the construction of soil-aggregate sub-base measured as provided above, the Contractor shall be paid the contract price per mile which shall be full compensation for furnishing and applying water and for doing all the work necessary for the completion of the soil-aggregate sub-base in compliance with the plans and specifications.

For the number of tons of granular material furnished and



incorporated in the work the Contractor shall be paid the contract price per ton.

### Section 2109. Natural Subgrade

**2109.01 DESCRIPTION.** The construction of natural subgrade shall consist of the shaping and consolidation of an existing roadbed in preparation for the placement of a base course, surface course or pavement.

**2109.02 NATURAL SUBGRADE FOR TRAFFIC COMPACTED SURFACE.** Unless otherwise provided, natural subgrade for traffic compacted surface courses will be prepared by County forces without cost to the Contractor.

**2109.03 NATURAL SUBGRADE FOR CONCRETE PAVEMENT OR BASE COURSE.** The subgrade shall be so constructed as to have uniform density for a width at least equal to that of the proposed pavement plus one foot on each side. It shall be brought to an elevation and cross section such that after being rolled the surface will be at the required elevation. At the time the subgrade is prepared the roadbed shall have been constructed to the full width and to at least the elevation of the finished subgrade. In cases where the material present in the 6 inches next below the elevation of the subgrade is not reasonably uniform as to composition or density for the full width of the subgrade these materials shall be scarified, mixed, and re-compacted or otherwise treated to produce a uniform condition. Stone over 4 inches in size shall be removed from the loosened portion of the subgrade and disposed of as directed by the Engineer.

Depressions that develop during the rolling shall be filled with suitable material and the rolling shall continue until the subgrade is uniformly firm, properly shaped and true to grade and cross section. It shall be so maintained until the pavement is placed. Material (other than sand) which will not compact readily under the roller shall be removed and replaced with material which will compact readily and that portion of the subgrade shall be rolled again. The roller used shall weigh not less than three tons.

The rolling of the subgrade shall extend for at least 12 inches outside of each edge of the proposed pavement. Piles or ridges of earth or material that would seriously interfere with the operations of finishing the pavement shall not be left on the shoulders.



During the process of constructing subgrade the soil shall be maintained in a condition sufficiently moist as to facilitate compaction and produce a firm, compact surface. Such sprinkling or wetting of the finished subgrade will be required as may be necessary to insure a reasonable moisture content at the time concrete is placed upon it.

If in the preparation of the subgrade it becomes necessary to excavate below the elevation of the earth shoulders, ditches or drains shall be provided at frequent intervals to permit ready drainage of surface water from subgrade to side ditches.

If ruts or other objectionable irregularities form in the subgrade during construction the Contractor shall reshape and reroll the subgrade before the pavement is laid. The material used for filling ruts or other depressions shall be of such character as to make it equally as desirable for subgrade purposes as the material present in the subgrade.

For sections of pavement more than 300 feet long, the subgrade shall be completed not less than 300 feet in advance of the operation of placing the concrete.

The following shall apply to the construction of subgrade for pavement or base course required to be built between straight sections of steel forms or other equally straight, parallel and substantial boundaries. Wherever the quantity of pavement or base course of uniform width and cross section is great enough to make the method practical, and particularly in cases where the mixer or other traffic travels on the subgrade, the subgrade shall be finished in the following manner:

A steel-shod template resting on the side forms shall be drawn over the subgrade before the paving material is deposited. This template shall be made of steel and its rigidity shall be at least equal in all respects to that of a 10-inch I-beam, 25-pound section, with the web vertical. Its cutting edge shall consist of adjustable blades which shall be set so as to leave the subgrade at the elevation necessary to produce pavement of the thickness shown on the plans. Each end of the template shall be supported on the forms by means of two visible rollers spaced not less than 36 inches apart. Means shall be provided for drawing the template back and forth over the subgrade as many times as may be necessary to bring the subgrade to proper section and elevation. If the template is operated in an area occupied by reinforcing rods, provision shall be made for passing the reinforcing steel through the template in such a way that it will be left in correct position



**2110.03 PROGRESS OF THE WORK.** Shouldering operations shall be commenced as soon as the paving operations have advanced to a point which will permit continued progress in completion of final grading operations and the shoulders shall be completed within the period set forth in the special provisions after the completion of the pavement slab, but not to exceed thirty days.

**2110.04 FINISHING.** After the earth shoulders have been compacted they shall be shaped to the specified cross section and smoothed to a condition acceptable to the Engineer. The Contractor shall also smooth and finish any earth surfaces which have been constructed under his contract and shall restore to an acceptable condition any sections of the right of way which have been disturbed by his operations. The degree of finish for slopes, shoulders and ditches shall be that ordinarily obtainable through the use of suitable power equipment operated by skilled workmen under favorable conditions. Hand methods of finishing will be required only in the event that satisfactory results are not otherwise obtained.

**2110.05 METHOD OF MEASUREMENT.** Material excavated for building shoulders will be measured in cubic yards as provided in Article 2102.12.

The material used for surfacing intersecting roads, drives and turnouts shall be measured as provided in Article 2307.08. The excavation incidental to the surfacing of intersecting roads, drives and turnouts will not be measured for payment.

The Engineer will compute in stations of 100 lineal feet the length of shoulder finished by the Contractor from measurement along each shoulder. (For 100 feet of pavement with shoulder on two sides the quantity will be two stations).

**2110.06 BASIS OF PAYMENT.** For excavation necessary for building the shoulders the Contractor will be paid the contract price per cubic yard as provided in Article 2102.13.

For finishing earth shoulder measured as provided above the Contractor shall be paid the contract price per station. This price shall be full compensation for furnishing all labor and equipment and performance of all work necessary to finish the earth surfaces in an acceptable manner.

For surfacing intersecting roads, drives and turnouts the Contractor will be paid as provided in Paragraph 2202.13C.



## DIVISION 22. BASE COURSES

Base courses shall be constructed on prepared subgrade. They shall consist of construction in accordance with the requirements specified for the various types in the following sections:

- 2201. Portland Cement Concrete Base.
- 2202. Rolled Stone Base.
- 2203. Soil Aggregate Base, Plant Mixed Type.
- 2204. Soil Cement Base.
- 2205. Soil Aggregate Base Course, Road Mixed Type.

### Section 2201. Portland Cement Concrete Base

**2201.01 DESCRIPTION.** This work shall consist of construction on a prepared subgrade of a base course of Portland cement concrete of the materials specified, and in conformity with the plans and these specifications.

**2201.02 CONSTRUCTION.** The materials and methods of construction specified for Portland cement concrete pavement, Section 2301 shall apply to construction of Portland cement concrete base course, except that when a bituminous surface is to be placed upon the concrete base the surface to receive the bituminous top shall be given a "broom finish." The surface shall be broomed with a stiff fiber broom drawn over the surface transversely at such time after the final belting that the concrete has hardened enough to receive and retain broom marks with one stroke of the broom.

**2201.03 BASIS OF PAYMENT.** This type of construction will not be paid for separately but shall be considered as subsidiary part of construction of the pavement of the type specified in the contract and included in the contract unit price therefore.

### Section 2202. Rolled Stone Base

**2202.01 DESCRIPTION.** Rolled stone base shall consist of crushed stone containing a full range of sizes of particles placed on a prepared subgrade uniformly moistened, thoroughly compacted and primed with a bituminous primer all in accordance with these specifications and in conformance with the plans.



- B. **Moisture Content.** Water in an amount not less than that which will insure maximum compaction shall be uniformly distributed throughout the depth of the material to be compacted so that all particles are uniformly wetted. That moisture content which will insure maximum compaction shall be maintained in the aggregate until the compaction of the base is completed.
- C. **Spreading Aggregate.** The base material shall be spread to such width and depth that the compacted base will conform to the desired profile and cross section. The spreading shall be done in such a way that the uniformity of the base material and its moisture content will be maintained.
- D. **Compaction.** Promptly after the aggregate has been brought to the proper moisture content and spread, it shall be thoroughly and uniformly compacted to not less than maximum density as defined in Article 1101.01. During the compaction process such wetting and shaping shall be performed as may be necessary to insure proper compaction and the required profile and cross section of the finished base. If the quantity of material disturbed by shaping and trimming operations is of any consequential amount it shall be thoroughly incorporated in the finished base.

If the base is compacted in more than one layer the surface of each layer shall be moist and sufficiently rough to insure proper bond before material for the succeeding layer is placed upon it. Each layer shall be placed and compaction begun upon it not later than the next working day after the preceding layer was compacted. If the delivery, spreading or compaction of material in layers causes preceding layers to be disturbed the Engineer may require the material to be compacted in fewer layers and may require the contractor to furnish equipment adapted to the changed method of construction without extra compensation.

Whether the base is compacted in one or more layers, the compaction of each layer shall be continued until the required density is obtained, the final rolling is completed and the finished surface is generally free of loose material.

The finished surface of the base shall be true to



profile and cross section as shown on the plans, shall be free from irregularities and loose material and shall have a smooth riding surface. The final rolling shall be done with a smooth faced steel roller and a pneumatic tired roller. The cross section shall be checked with an accurate template extending at least half way across the width of the base and deviations of more than one-half inch from this template shall be corrected. The edges of the base shall be trimmed to neat lines to the width shown on the typical cross section.

**2202.06 PRIMING BASE COURSE AND SUBGRADE.** The entire surface of the base including the edge slopes, and the subgrade for a width of one foot adjacent to each edge of the base, shall be primed with the specified bituminous material.

Before any material for building up the shoulders has been placed, the entire exposed surface of the base and the adjacent subgrade for a width of one foot shall be made free of all loose material. Primer material shall then be applied to the edge slopes of the base and the adjacent one foot width of subgrade at the rate of 0.3 gallons per square yard. When this material has been absorbed and set, primer material shall be applied to the entire surface of the base and adjacent one foot width of subgrade at a rate specified on the plans.

The distributor shall be operated at such speed and with such control setting as will deliver the desired quantity of bituminous material per square yard. Adjacent applications of primer shall lap approximately six inches.

The quantity applied for any length of road being worked as a unit shall be between 95 and 105 per cent of the quantity specified. The rate of application shall be corrected for temperature to provide the desired volume at 60°F. The curbs and hand rails of bridges, the headwalls of culverts and exposed parts of other structures shall be protected by a suitable covering to prevent them from being soiled from bitumen. Such covering shall remain in place until the bitumen has set to the extent that no splashing will occur under traffic. The primer shall be allowed to remain exposed and entirely free from traffic until it has thoroughly penetrated the base and for at least 24 hours. If at the end of 24 hours after application pools or spots of excess bitumen remain on the road surface the Engineer may require such pools or spots to be hand broomed to prevent the primer from being picked up.

If portions of the priming coat fail to adhere to the road



surface because of dust or loose material or moisture, or if the surface becomes displaced or rutted by traffic, the Engineer may require these areas to be thoroughly cleaned and re-primed at the contract price for primer bitumen applied.

Bituminous material shall be applied as primer, only when the road surface is dry and warm enough to insure proper penetration. This will usually require that the temperature of the road surface be not lower than 70°F.

**2202.07 STORAGE OF EXCESS BITUMEN.** The provisions of Paragraph 2305.04C(4) shall apply to the bitumen required for this work.

**2202.08 SHOULDERS.** After the base course has been completed and primed the shoulders shall be raised to the general elevation shown on the plans by filling with suitable material obtained from borrow pits as shown on the plans.

The material shall be spread in uniform layers of not more than 6 inches in loose thickness. Each layer shall be brought to a moisture condition favorable for compaction and rolled at least 6 times with a pneumatic tired roller. Particular attention shall be exercised to insure the thorough compaction against and adjacent to the edge of the base. The shoulders shall be finished to a smooth surface with the cross section shown on the plans. The construction of shoulders may be deferred until the surface course is completed.

**2202.09 SURFACING APPROACHES TO INTERSECTING ROADS, DRIVEWAYS AND TURNOUTS.** The approaches to intersecting roads, drives and turnouts for mail boxes shall be surfaced as directed by the Engineer with material conforming to the requirements of Paragraph 2202.02C. Before the surfacing material is placed, such excavating shall be done as may be necessary to bring the finished surface to the general elevation of the shoulder and insure drainage away from the roadbed. The surfacing material shall be spread to a uniform thickness.

**2202.10 FINISHING.** After the base course and shoulders have been completed, the Contractor shall place in acceptable condition any portion of the right of way that has been disturbed by his operations and in accordance with the provisions of Article 2102.10.

**2202.11 MAINTENANCE OF COMPLETED BASE.** These specifications contemplate that a prime coat shall be placed



immediately after the base has been compacted to the required density and shaped to the required profile and cross section. In case the prime coat is not placed immediately the Contractor shall maintain the completed base in a smooth condition free from loose surface material, at his own expense, until the prime coat is placed. The work will be accepted by sections of one mile or more in length as rapidly as all the work on each section is completed in a satisfactory manner.

**2202.12 METHOD OF MEASUREMENT.** The quantities of the various classes of work involved in the construction of rolled stone base will be measured by the Engineer as follows:

- A. **Preparation of Subgrade.** Natural subgrade prepared for rolled stone base will be measured in miles along the centerline of the base course. At intersections the length measured for payment shall not include that portion which overlaps previously constructed or previously measured pavement, base course or subgrade. Subgrade prepared for the gravel surfacing of approaches to intersecting roads, driveways and turnouts will not be measured for payment.
- B. **Excavation.** Material excavated for building shoulders will be measured in cubic yards as provided in Article 2102.12. Excavation required for the placement of surfacing at intersecting roads, drives and turnouts will not be measured.
- C. **Surfacing for Roadways, Drives and Turnouts.** The quantity of surfacing material shall be measured as provided for the measurement of gravel surfacing material, Article 2307.08.
- D. **Base Material.** All aggregate used in accepted portions of the base will be measured in tons of 2000 pounds. The number of tons delivered will be computed by the Engineer from weights of individual truck loads deducting for the free moisture present in the material.
- E. **Bituminous Material.** All volumes of bituminous material applied as primer will be measured in U. S. Standard gallons at 60°F. in accordance with the provisions of Article 4101.03.

**2202.13 BASIS OF PAYMENT.** For the performance of the various classes of work involved in the construction of rolled stone base measured as provided above, the Contractor will be



paid the contract unit prices which shall be full compensation for furnishing all materials, equipment, tools and labor and for the performance of all incidental work necessary to complete the base in accordance with the plans and these specifications.

- A. **Preparation of Subgrade.** For the preparation of subgrade the Contractor will be paid at the contract price per mile which shall be considered full payment for all work performed and any water required in the operation.
- B. **Excavation.** For the quantity of material excavated for building shoulders the Contractor will be paid the contract price per cubic yard. The quantity of excavation may vary from the contract quantity by more than 20% but the contract price and not the provisions of Article 1109.03 shall apply regardless of such variations.
- C. **Surfacing for Intersecting Roads, Drives and Turnouts.** The Contractor will be paid the unit contract price for material for surfacing approaches to intersecting roads, drives and turnouts. This price shall be considered full compensation for any necessary excavation incidental to this work and for furnishing, placing and spreading the material.
- D. **Base Material.** For all aggregate used in the base the Contractor will be paid the contract price per ton for rolled stone base material. This price shall be considered full compensation for furnishing all material including water and for all operations involved in the construction of the base not paid for in other items.
- E. **Bituminous Material.** For bituminous material used as primer or delivered to the County for storage, the Contractor will be paid the contract price per gallon.

### Section 2203. Soil Aggregate Base Course, Plant Mixed Type

**2203.01 DESCRIPTION.** Soil aggregate base shall consist of an accurately proportioned uniform mixture of aggregate, soil binder and water placed on a prepared subgrade, compacted and primed with a bituminous primer all in conformance with the plans and these specifications.

**2203.02 MATERIALS.** At least ten days before any material for the soil aggregate mixture is delivered the Contractor shall



notify the Engineer as to the source from which he intends to secure each of the required materials and shall provide the Engineer with facilities for obtaining representative samples of each of these materials. These samples will be tested by the Engineer and from the results of these tests the Engineer will determine whether or not materials conforming to the samples are acceptable and will notify the Contractor accordingly. From these tests the Engineer will compute the proportions in which the various acceptable materials may be combined to produce a mixture complying with the requirements of these specifications. The material used in the work shall conform to the preliminary samples to the extent that the percentage passing each testing sieve is not more than  $1\frac{1}{4}$  times, nor less than  $\frac{3}{4}$  times the percentage of the preliminary sample passing the same sieve. The Contractor may be required to stock pile or otherwise handle the material to insure compliance with this requirement. In case the Contractor elects to change sources of materials to sources not represented by preliminary samples, the Engineer shall be allowed five normal working days to make necessary tests and computations without claim for delay on the part of the Contractor. This time shall be computed from the time samples are made available to the Engineer by the Contractor to the time the Contractor is notified of the results of tests.

Materials used shall conform to the following requirements:

**A. Aggregates.** Aggregate for the base mixture shall be a uniform mixture of coarse and fine particles of gravel or crushed stone, a combination of these materials, or a combination of either or both of these materials with sand. Clay and silt naturally occurring in the material will not be considered objectionable provided it remains finely divided and uniformly distributed. The material shall conform to the following detailed requirements:

1. **Gravel.** Except as to grading, gravel shall conform to the requirements for gravel for gravel surfacing, Section 4108.
2. **Crushed Stone.** Except as to grading, crushed stone shall conform to the requirements for stone for rolled stone base course, Article 4109.02.
3. **Sand.** The percentage of shale particles retained on a Number 16 sieve shall not exceed 5.0.

**B. Binder Soil.** Binder soil shall comply with the requirements of Paragraph 4109.03B. Before the binder soil is



mixed with aggregate it shall be pulverized to such an extent that tests of representative samples of the finished mixture shall not show soil particles retained on a Number 4 sieve in an amount greater than 15 per cent of the amount of soil added.

- C. **Base Mixture.** The final mixture of aggregate and binder soil shall conform to the requirements of Paragraph 4109.03C.
- D. **Admixtures.** The requirements for any chemical admixture to be included in the soil-aggregate base mixture will be set forth in the Special Provisions.
- E. **Primer Bitumen.** The material used for the prime coat shall be of the type and grade specified in the contract.

**2203.03 EQUIPMENT.** The equipment used shall be of types approved by the Engineer and shall be maintained in satisfactory working condition. No equipment operating on the primed or unprimed finished base shall have a greater wheel or axle load than the maximum which may be operated legally on the public roads of Iowa. Tractors with lugs shall not be used for manipulating or spreading the base material.

- A. **Proportioning Equipment.** The equipment used for providing the desired proportions of the various ingredients in the finished mixture shall be adapted to the methods of handling and mixing employed. It shall be capable of such adjustment and control that the quantity of each material in any five-ton unit shall not vary more than 10 per cent from the intended quantity of that material in that unit. Elevated bins shall comply with the provisions of Article 2301.07, except that the grille specified will not be required if the method of delivery and handling materials is such that this grille is not necessary for the removal of foreign material or the safety of the workmen.
- B. **Mixing Equipment.** The equipment used for mixing the base material shall be so designed, operated and controlled as to deliver a uniform and intimate mixture of all the ingredients, including water, without the storage of unmixed material on the subgrade.
- C. **Weighing Equipment.** Weighing equipment used for determining pay quantities or for proportioning the mixture shall be of a type adapted to its method of use. Scales used for weighing loaded trucks shall have suf-



ficient capacity to weigh the maximum gross truck load. They shall be accurate to 0.5% of the total load and sensitive to 10 pounds. Scales used for handling and weighing batches shall conform to the requirements of Paragraph 2301.16C.

D. **Compaction Equipment.** Compaction equipment shall comply with the provisions of Paragraph 2202.03B.

E. **Equipment for Priming Base.** The equipment used for sweeping the base and applying the bituminous primer shall comply with the requirements of Section 2305.

**2203.04 PREPARATION OF SUBGRADE.** The subgrade for soil-aggregate base shall be prepared in accordance with the provisions of Section 2108 or Section 2109, as specified in the contract. At the time the base material is deposited upon it and at the time the base material is compacted the subgrade beneath it shall be firm and shall be moist to a depth of at least one-half inch.

**2203.05 CONSTRUCTION.** Soil-aggregate base shall be constructed on the prepared subgrade in accordance with the following provisions:

A. **Mixing.** Material for soil-aggregate base shall be mixed in a manner which does not involve storage of the unmixed material on the subgrade of the road to be improved. All the ingredients of the mixture shall be thoroughly and uniformly mixed in the prescribed proportions. The amount of water in the mixture as discharged from the mixer shall be uniform and not less than the quantity which will insure uniform distribution of the soil binder and maximum density when compacted, and not more than 120 per cent of that quantity.

B. **Delivery of Base Mixture.** The mixed material of a soil-aggregate base shall be delivered in accordance with the provisions of Paragraph 2202.05A.

C. **Spreading Base Mixture.** The mixed material for soil-aggregate base shall be spread in accordance with the provisions of Paragraph 2202.05C.

D. **Compaction.** Soil aggregate base shall be compacted in accordance with the provisions of Paragraph 2202.05D.

**2203.06 PRIMING BASE COURSE AND SUBGRADE.** The entire surface of the base, including the edge slopes, and



the subgrade for a width of one foot adjacent to each edge of the base shall be primed in accordance with the provisions of Article 2202.06.

**2203.07 STORAGE OF EXCESS BITUMEN.** The provisions of Paragraph 2305.04C(4) shall apply to this work.

**2203.08 SHOULDERS.** Shoulders shall be constructed in accordance with the provisions of Article 2202.08.

**2203.09 SURFACING APPROACHES TO INTERSECTING ROADS, DRIVEWAYS AND TURNOUTS.** The approaches to intersecting roads, driveways and turnouts for mail boxes shall be surfaced in accordance with the provisions of Article 2202.09, except that the materials used for the soil-aggregate base may be used for this purpose.

**2203.10 FINISHING.** After the base course and shoulders have been completed the Contractor shall place in acceptable condition any portion of the right of way that has been disturbed by his operations and in accordance with the provisions of Article 2102.10.

**2203.11 MAINTENANCE OF COMPLETED BASE.** The completed base shall be maintained by the Contractor in accordance with the provisions of Article 2202.11.

**2203.12 METHOD OF MEASUREMENT.** The quantities of the various classes of work involved in the construction of soil-aggregate base will be measured by the Engineer as follows:

- A. **Preparation of Subgrade.** The subgrade prepared for soil-aggregate base will be measured in accordance with the provisions of Paragraph 2202.12A.
- B. **Excavation.** Material excavated for building shoulders will be measured in cubic yards as provided in Article 2102.12. Excavation required for the placement of surfacing at intersecting roads, drives and turnouts will not be measured.
- C. **Surfacing for Roadways, Drives and Turnouts.** The quantity of surfacing delivered for surfacing approaches to intersecting roads, driveways and turnouts shall be measured as provided for the measurement of gravel surfacing, Article 2307.08.



D. **Base Material.** Aggregates and soil used in accepted portions of the soil-aggregate base will be measured in tons of 2,000 pounds. The number of tons delivered shall be computed by the Engineer from weights of individual batches or truck loads, deducting for the free moisture present in the material.

E. **Bituminous Material.** All volumes of bituminous material applied as primer will be measured in U. S. Standard gallons at 60°F. in accordance with the provisions of Article 4101.03.

**2203.13 BASIS OF PAYMENT.** For the performance of the various classes of work involved in the construction of soil-aggregate base measured as provided above, the Contractor shall be paid the contract unit prices which shall be full compensation for furnishing all materials, equipment, tools and labor for the performance of all incidental work necessary to complete the base in accordance with the plans and these specifications.

A. **Preparation of Subgrade.** For the preparation of subgrade, the Contractor will be paid at the contract price per mile, which shall be considered full payment for all work performed and any water required in the operation.

B. **Excavation.** For the quantity of material excavated for building shoulders, the Contractor will be paid at the contract price per cubic yard. The quantity of excavation may vary more than 20 per cent, but the contract price and not the provisions of Article 1109.03 shall apply regardless of such variation.

C. **Surfacing Intersecting Roads, Drives and Turnouts.** The contractor will be paid at the unit contract price for material for surfacing approaches to intersecting roads, drives and turnouts for mail boxes. This price shall be considered full compensation for any necessary excavation incidental to this work and for furnishing, placing and spreading the material.

D. **Base Material.** For all aggregates and soil in the base, the Contractor will be paid the contract price per ton. This price shall be considered full compensation for furnishing all material, including water, and for all operations involved in the construction of the base not paid for in other items.



- E. **Bituminous Material.** For bituminous material used as primer or delivered to the County for storage the Contractor will be paid the contract price per gallon.

### Section 2204. Soil-Cement Base

**2204.01 DESCRIPTION.** Soil-cement base shall consist of a combination of soil, Portland cement and water uniformly mixed, thoroughly compacted and primed with a bituminous primer all in accordance with these specifications and in conformance with the plans.

**2204.02 MATERIALS.** The materials used shall conform to the following requirements:

- A. **Cement.** Portland cement shall conform to the requirements of Section 4102, Type I.
- B. **Water.** Water shall comply with the requirements of Section 4103.
- C. **Soil.** The soil used shall be taken from the road surface within the width of base to be constructed, except as otherwise provided on the plans or in the Special Provisions.
- D. **Bitumen.** The bituminous material used for the prime coat shall be of the type and grade specified in the contract.
- E. **Aggregate.** Aggregate required to be furnished and incorporated in the base under the special provisions shall conform to the requirements stipulated therein.

Material used for surfacing approaches to intersecting roads, driveways and turnouts for mail boxes may be any one of the materials specified in Section 4108.

**2204.03 EQUIPMENT.** The equipment used shall be of types approved by the Engineer and shall be maintained in satisfactory working condition. No equipment operating on the primed or unprimed finished base shall have a greater wheel or axle load than the maximum which may be operated legally on the public roads of Iowa.

- A. **Scarifying and Mixing Equipment.** Scarifying and mixing equipment used shall be so designed and operated as to loosen and mix the material to an accurately controlled depth. In addition to all other equipment furnished for loosening material derived from the subgrade,



pulverizing the soil and performing the various required mixing operations, the following equipment shall be furnished for loosening material derived from the subgrade, mixing cement with soil, and mixing the soil and cement mixture with water:

1. Gang plows of the heavy duty type, each with three or more bottoms with 14- to 18-inch mold boards and with power lift and means for accurate control of depth.
2. Offset disc harrows of heavy duty type at least 9 feet wide, and with discs at least 22 inches in diameter, equipped with disc cleaners.
3. Either power driver rotary mixers or heavy duty field cultivators having a width of not less than 8 feet with 4-inch double pointed shovels and means for accurate depth control.

**B. Equipment for Applying Water.** Equipment for applying water to the mixture for road mixing shall comply with the requirements for bituminous distributors, Paragraph 2305.03B, except that heating equipment and thermometers will not be required.

**C. Compacting Equipment.** The equipment used for the initial compaction of the base shall be tamping type rollers complying with the requirements of Article 2106.02. The equipment used for the final rolling of the base shall be pneumatic tired rollers complying with the requirements of Paragraph 2202.03B and a smooth faced steel roller weighing not less than 200 pounds per inch of width of roller.

**D. Finishing Equipment.** Nail drags shall be not less than 8 feet wide and shall be constructed to provide transverse rows of 8-inch common spikes. The spikes shall extend not less than  $1\frac{1}{2}$  inches below the supporting frame and shall be so mounted on the frame as to provide two transverse rows of spikes at intervals of not more than  $1\frac{1}{4}$  inches per row. Broom drags shall be not less than 8 feet wide and shall be equipped with not less than two rows of metal or heavy fiber brushes with bristles 4 to 6 inches long.

**E. Equipment for Priming Base.** The equipment used for sweeping the base and for applying the bituminous



primer shall comply with the requirements of Section 2305.

- F. **Weighing Equipment.** Weighing equipment used shall conform to the requirements of Paragraph 2202.03A.
- G. **Equalizing Equipment.** Windrow equalizers used for distributing base material hauled to the roadbed shall be so designed as to deliver a windrow of uniform and accurately controlled cross section. They shall have sufficient weight to hold themselves firmly to the roadbed while being drawn over the windrow. Spreader boxes shall be so designed and constructed that a uniform quantity of material will be delivered per lineal unit of travel.
- H. **Cement Spreaders.** Cement shall be spread by a device or method which will distribute the cement uniformly at the prescribed rate over the surface of the material upon which the cement is being placed.

**2204.04 PREPARATION OF ROADBED.** Unless the base is to be placed on a soil-aggregate sub-base, the roadbed shall be prepared in accordance with one or the other of the following provisions, depending upon the source of the major portion of the soil material to be used in the base:

- A. **Soil for Base Taken From Roadbed.** Any surfacing material which is present on the road shall be bladed into a windrow to prevent its loss. The roadbed shall then be shaped as necessary to conform to the lines, grades and cross section shown on the plans.

In any case where the shaping of the roadbed results in a depth of disturbed soil greater than one inch, such disturbed soil shall be compacted to a density not less than that of the undisturbed soil in that area. At the time of compaction the moisture content of the soil shall be maintained at that which is favorable for compaction.

The prepared roadbed shall be checked with an accurate template extending at least half way across the width of roadbed and deviations of more than one inch from this template shall be corrected. After the roadbed has been shaped and checked, the surfacing material which was windrowed shall be spread uniformly over the area to be occupied by the base.

- B. **Soil for Base Imported.** Where the soil for the base is



to be derived from some source other than the roadbed, the roadbed shall be prepared in accordance with the provisions of Section 2109. At the time the base material is placed upon it, and at the time the base material is compacted, the subgrade shall be firm and shall be moist for a depth at least one-half inch.

**2204.05 CONSTRUCTION.** Soil-cement base shall be constructed on the prepared roadbed in conformance with the following requirements:

- A. **Delivery of Aggregate.** When the soil for the base is obtained from the roadbed any aggregate required by the special provisions for incorporation in the base mixture shall be distributed uniformly on the roadbed by means of spreader boxes or windrow equalizers at the rate specified. Such material shall be spread uniformly over the surface to be occupied by the base.
- B. **Scarifying Subgrade.** When the soil for the base is to be taken from the existing roadbed, the soil to be treated shall be scarified and pulverized for a sufficient width and depth to provide the compacted cross section of base shown on the plans. Such scarifying and pulverizing shall be completed before the cement is applied to the soil. Care shall be exercised to insure that the depth to which the soil is loosened is not greater nor less than that necessary to provide the quantity required for the thickness of base specified. The Engineer will provide stakes at the sides of the roadway at intervals of not more than 100 feet. From these stakes the Contractor shall make frequent measurements during the scarifying and pulverizing operations to insure proper control of the depth to which soil is loosened. The Contractor shall furnish such help as the Engineer may require to check such measurements.
- C. **Pulverizing.** At the time the cement is applied, the soil shall be pulverized to such extent that all the soil particles will pass through a one-inch sieve and at least 80 per cent of the soil particles will pass a Number 4 sieve.
- D. **Application of Cement.** After being pulverized, the soil or soil-aggregate mixture shall be spread to the specified width of base and to uniform depth. Cement shall then be spread uniformly over the surface by means of



spreaders or by other methods which will insure uniform distribution, at the rate specified. Cement shall not be applied to soil having a percentage of moisture in excess of the optimum for the soil-cement mixture minus two. No equipment except that required for mixing the cement and soil shall be allowed to pass over the freshly spread cement.

**E. Mixing.** Immediately after the cement has been spread it shall be mixed with the pulverized soil or soil-aggregate mixture. Mixing may be accomplished with heavy duty field cultivators, gang plows, disc harrows, rotary tillers and any combination of these kinds of equipment with other equipment approved by the Engineer. Mixing shall be continued until a thorough, uniform mixture of the aggregate, soil and cement is attained. The mixture shall then be shaped to the approximate lines and grades shown on the plans.

**F. Application of Water.** Immediately after the above prescribed mixing and spreading processes have been completed, water shall be added uniformly at the rates and in the quantities specified by the Engineer. After each application of water the mixture shall be manipulated by means of the equipment specified above for mixing, to avoid concentration of water near the surface. After the required total amount of water has been added, mixing shall continue until a uniform moisture content for the full depth of the mixture has been attained.

The amount of moisture present in the mixture at the completion of the wetting and mixing shall not be less than the optimum moisture content nor more than 130 per cent of this quantity.

**G. Spreading and Compacting.** The wetted mixture shall be uniformly spread over the area to be occupied by the base to the lines shown on the plans, and shall then be uniformly loosened to its full width and depth. It shall then be uniformly compacted from the bottom upward to not less than 90 per cent of the maximum density as defined in Article 1101.01, determined on a representative sample of the soil mixed with the designed quantity of cement. The initial compaction shall be accomplished with tamping type rollers or other equipment, approved by the Engineer, which will produce equivalent results.



The rate of operation and number of compacting units shall be sufficient to insure that the section being processed will be uniformly compacted to the specified density for its full length, width and depth within a period of two hours from the time such compaction is started. The uniform composition of the mixture shall be maintained during the spreading and compacting operations.

After the base, except for the upper  $1\frac{1}{2}$  inches, has been compacted the cross section shall be checked with an accurate template extending at least half way across the base. Deviations of more than one-half inch from this template shall be corrected. The surface of the base shall be bladed with a motor grader to secure a uniform cross section free from surface irregularities. The surface shall be loosened to a depth of approximately one inch with a nail drag. The drag shall be of sufficient weight and shall have a sufficient number of teeth to thoroughly loosen the surface and eliminate all roller marks. During and after the dragging operation the surface shall be smoothed with a broom drag to produce a surface free from longitudinal ridges. The loose mulch thus produced shall be brought to a moisture content which will insure proper compaction and adhesion. The resulting surface shall then be rolled with a pneumatic tired roller and a smooth faced steel roller until all loose material has been thoroughly compacted and the surface brought to a smooth condition. The rolling shall be supplemented with nail drags and broom drags.

H. **Header.** A header board shall be placed perpendicular to the subgrade and at right angles to the centerline near the end of each day's run. This header shall be placed in a trench cut through the complete base at such a location as to exclude all that part of the base, and at the end of the run, which does not have full depth, is not thoroughly compacted, not properly proportioned or not properly mixed. The material thus excluded shall be removed from the subgrade, broken up and distributed thinly over the adjacent area of the succeeding run. The header shall remain in place until the beginning of the compaction of the base mixture of the following day's run. Extreme care shall be exercised to overcome any tendency for the base in the



vicinity of the junction between runs to fail to be full thickness and true to grade, or to be inadequately compacted, improperly proportioned, inadequately wetted or incompletely mixed.

- I. **Turn Around.** A mat on which to turn equipment shall be provided and placed at the end of the previous day's run. No equipment shall be permitted to turn on the unprotected surface of a previous day's run or on the section of base being constructed after the cement has been spread. The size and type of mat shall be approved by the Engineer.
- J. **Final Finishing.** Not later than the beginning of the next working day after the construction of each section of base the surface shall be smoothed with a blade adjusted to the lightest cut which will insure a smooth riding surface. The material removed shall be wasted on the shoulders. Additional wetting and rolling during and after the finishing operation may be required.
- K. **Density of Finished Base.** The base completed each working day shall be divided into sections of equal length as near 500 feet as possible. The density of the compacted base shall be determined at a representative location in each section. If the density thus determined for any section is less than the minimum specified in Paragraph 2204.05G, two additional density determinations shall be made for that section. If the average of the results of these three determinations is less than 95 per cent of the minimum specified in Paragraph 2204.05G, that section shall be reconstructed with the addition of one-half the quantity of cement originally incorporated in the mixture and in full compliance with the foregoing requirements. Such reconstruction shall be entirely at the Contractor's expense.

If the average of the results of three density determinations for any section is more than 95 per cent of the minimum specified in Paragraph 2204.05G, but less than 100 per cent of this minimum, the section may be accepted but the Engineer may require that the quantity of base construction undertaken the next succeeding working day shall not be more than two-thirds that constructed on the day the section found to be deficient in density was constructed.



L. **Curing.** The finished base shall be protected from loss of moisture for at least seven days by means of one of the curing agents specified in Article 2301.24. These methods require initial curing with wet burlap, or other fabric mats. This initial wet curing may be omitted if the final curing medium is applied within the first five daylight hours without rain following the completion of the compaction operation specified in Paragraph 2204.05G, or if the prime coat is applied within the above specified period.

**2204.06 LIMITATIONS OF OPERATIONS.** Cement shall be applied only to such area that all operations specified in Paragraphs 2204.05D to 2204.05G, inclusive, can be continuous and completed within six hours after the beginning of the application of water to the soil-cement mixture.

The application of the full quantity of water required for any section being processed and the mixing of this water with the base material shall be completed within a period of three hours.

If any of the operations, after the application of cement, is interrupted for more than two hours, or if the soil-cement mixture is wetted by rain so that the moisture content exceeds the maximum specified in Paragraph 2204.05F, the Contractor may be required to reconstruct such section at his own expense.

The length of each day's proposed run shall be so governed as to insure that all operations, except the curing, will be completed during daylight hours.

No traffic except that incident to curing operations shall be permitted on the finished base during the curing period.

**2204.07 MACHINE MIXED OR PLANT MIXED BASE.** The foregoing specifications describe the method of construction involving mixing on the road by means of discs, barrows, and similar equipment. Other equipment which will produce equivalent results and which is approved by the Engineer may be used. The sequence of operations and details of construction may be varied with the approval of the Engineer to conform with the type of equipment used, subject to the time limitations for the various operations specified herein and the following restrictions:

A. The material as deposited on the roadway shall contain the full amount of water necessary for compaction to



maximum density with an estimated allowance for evaporation during the spreading and compacting processes.

- B. The proportioning equipment used shall provide accurate control of the proportions of all materials entering into the mixture, including water.
- C. In the case of material delivered to the subgrade in a windrow or in batches the mixture shall be spread within 15 minutes after it is deposited. The material shall be spread to the full width of the base, to the required uniform depth and in such a manner as to maintain a uniformly loosened condition.
- D. The compaction process shall follow immediately after spreading. The initial compaction shall be accomplished with equipment which will insure that the compaction will proceed from the bottom of the base upward.
- E. Equipment used for the application of water to the mixture after spreading shall comply with the requirement of Paragraph 2204.03B.
- F. The material to be mixed by continuous mixers traveling on the subgrade shall be placed in a layer or windrow of a shape adapted to the type of mixer used. Such windrow or layer shall be of uniform cross section and composed of a uniform mixture of soil and any aggregate that may be required. Cement shall not be spread on the soil more than one hour in advance of the mixing operation.
- G. The soil to be mixed by machines shall be pulverized to the extent that if passed through the machine without the addition of water it will comply with the requirements of Paragraph 2204.05C.
- H. Mixers designed to mix the material for less than the full width of the base at a single passage shall be so operated that the end of each day's run will be in a single straight line at right angles to the centerline of the roadway. At the end of each run a header shall be placed immediately after the mixed material is spread and in such a position as to reduce to a minimum the quantity of material required to be wasted.
- I. In the case of mixers operating on the subgrade sufficient loading and hauling of mixed and unmixed material shall be done to insure that the base in the vicinity



of the ends of runs will be of the full specified depth and at the required elevation.

**2204.08 PRIMING BASE COURSE.** The base shall be primed with the specified bituminous material in accordance with the following provisions. All loose or foreign material shall be removed from the surface by means of a power driven sweeper before the primer is applied.

The priming coat shall remain in place for at least 24 hours before any traffic will be allowed upon it or before any surface course is applied. If, at the end of 24 hours after application there remain pools or spots of excess bitumen on the road surface, the Engineer may require such pools or spots to be hand broomed or blotted with aggregate to prevent the primer being picked up by subsequent traffic.

If portions of the priming coat fail to adhere to the road surface because of dust, loose material or moisture or if the surface becomes displaced or rutted by traffic, the Engineer may require those portions to be thoroughly cleaned and re-primed at the contract price for primer bitumen applied.

Bituminous material shall be applied as primer only when the road surface is free from surface moisture and warm enough to obtain the proper adhesion. This will usually require a road surface temperature of 70°F. or higher.

If the material for the base course has been derived from the roadbed, the prime shall be applied to the exposed surface of the base. If the soil for the base has been imported, the base shall be primed in accordance with the provisions of Article 2202.06.

**2204.09 FINISHING EARTH SHOULDERS.** Earth shoulders shall be finished neatly to the lines and grades shown on the plans. The Contractor shall restore any part of the right-of-way disturbed by his operations and shall perform the clearing up operations prescribed in Article 1104.08.

Shoulders for bases composed of soil derived from a source other than the roadbed shall be constructed in accordance with the provisions of Article 2202.08.

**2204.10 SURFACING INTERSECTING ROADWAYS, DRIVES AND TURNOUTS.** The approaches to intersecting roadways and drives and turnouts for mail boxes shall be gravel surfaced as directed by the Engineer with one of the materials specified in Paragraph 2204.02E. The surfacing material shall be spread to a uniform thickness by the Contractor.



factory working condition. No equipment operating on the primed or unprimed finished base shall have a wheel load greater than the maximum which may be operated legally on the public roads of Iowa. Tractors with lugs shall not be used for manipulating or spreading the base material.

- A. **Proportioning Equipment.** The equipment used for distributing quantities of materials at rates less than 1000 tons per mile shall include a windrow equalizer which shall be of such design and weight as to control accurately the quantity of material in the windrow formed.
- B. **Mixing Equipment.** The mixing equipment used shall include a power driven rotating mixing unit. Except where the mixing machine used is designed to add water during the mixing process, the solid materials shall be thoroughly mixed before water is applied to them, and water shall be added in increments with thorough mixing between increments of water.
- C. **Weighing Equipment.** The weighing equipment used shall comply with the requirements of Paragraph 2202.03A.
- D. **Compaction Equipment.** The equipment used for compacting the base material shall comply with the requirements of Paragraph 2202.03B.
- E. **Equipment for Priming Base.** The equipment used for sweeping the base and for applying bituminous primer shall comply with the requirements of Section 2305, except that shields will not be required on power driven sweepers.

**2205.04 PREPARATION OF SUBGRADE.** The subgrade shall be prepared in accordance with Section 2108, or with Section 2109, as specified in the contract documents. At the time the base material is compacted the subgrade beneath it shall be firm and shall be moist to a depth of at least one-half inch.

**2205.05 CONSTRUCTION.** Soil-aggregate base, road mixed type shall be constructed in accordance with the following provisions:

- A. **Distribution of Solid Materials.** The solid materials for the base mixture shall be distributed on the subgrade in windrows of uniform cross section such that when mixed together the mixture will contain the required



percentage of particles of the various sizes. Windrows of materials distributed in quantities less than 1000 tons per mile shall be formed with an accurate windrow equalizer designed for that particular purpose. The Engineer may so control the rate of delivery of materials as to reduce to the least practical minimum the time the materials will remain on the subgrade in an uncompacted condition.

**B. Mixing.** All the ingredients of the mixture shall be thoroughly mixed in the prescribed proportions. The amount of water in the mixture at the time it is spread on the subgrade for compaction shall not be less than the quantity which will insure the uniform distribution of the soil binder and maximum density when compacted, and not more than 120 per cent of that quantity.

**C. Spreading Base Mixture.** The mixed material for the base course shall be spread in accordance with the provisions of Paragraph 2202.05C.

**D. Compaction.** The base course shall be compacted in accordance with the provisions of Paragraph 2202.05D.

**2205.06 PRIMING BASE COURSE AND SUBGRADE.** The entire surface of the base, including the edge slopes, and the subgrade for a width of one foot adjacent to each edge of the base shall be primed in accordance with the provisions of Article 2202.06.

**2205.07 STORAGE OF EXCESS BITUMEN.** The provisions of Paragraph 2305.04C(4) shall apply to this work.

**2205.08 SHOULDERS.** Shoulders shall be constructed in accordance with the provisions of Article 2202.08.

**2205.09 SURFACING APPROACHES TO INTERSECTING ROADS, DRIVEWAYS, AND TURNOUTS.** The approaches to intersecting roads, driveways, and turnouts for mail boxes shall be surfaced in accordance with the provisions of Article 2202.09 except that the soil-aggregate mixture used for the base may be used for this purpose.

**2205.10 FINISHING.** After the base course and shoulders have been completed the contractor shall place in acceptable condition any portion of the right of way that has been disturbed by his operations in accordance with the provisions of Article 2202.10.



**2205.11 MAINTENANCE OF COMPLETED BASE.** The completed base shall be maintained by the contractor in accordance with the provisions of Article 2202.11.

**2205.12 METHOD OF MEASUREMENT.** The quantities of the various classes of work involved in the construction of soil-aggregate base will be measured by the Engineer as follows:

- A. **Preparation of Subgrade.** The subgrade prepared for soil-aggregate base will be measured in accordance with the provisions of Paragraph 2202.12A.
- B. **Excavation.** Material excavated for building shoulders will be measured in cubic yards as provided in Article 2102.12. Excavation required for the placement of surfacing at intersecting roads, drives, and turnouts will not be measured.
- C. **Surfacing for Approaches to Intersecting Roadways, Drives, and Turnouts.** The quantity of material delivered for surfacing approaches to intersecting roads, driveways, and turnouts for mail boxes will be measured in accordance with the provisions of Article 2307.08.
- D. **Base Material.** Aggregate and soil used in accepted portions of the soil-aggregate base will be measured in tons of 2000 pounds. The number of tons delivered will be computed by the Engineer from weights of individual truck loads, deducting for the free moisture present in the material.
- E. **Bituminous Material.** All volumes of bituminous material applied as primer will be measured in U. S. standard gallons at 60°F. in accordance with the provisions of Article 4101.03.

**2205.13 BASIS OF PAYMENT.** For the performance of the various classes of work involved in the construction of soil-aggregate base, measured as provided above, the contractor shall be paid the contract unit prices which shall be full compensation for furnishing all materials, equipment, tools, and labor for the performance of all work necessary to complete the work in accordance with the plans and these specifications.

- A. **Preparation of Subgrade.** For the preparation of subgrade, the contractor shall be paid the contract price per mile which shall be full payment for all work performed and any water required in the operation.



- B. Excavation.** For the quantity of material excavated for building shoulders, the contractor shall be paid the contract price per cubic yard. The quantity of excavation may vary more than 20 per cent from the contract quantity, but the contract unit price and not the provisions of Article 1109.03 shall apply regardless of such variation. No payment for overhaul will be made on material obtained from borrow pits shown on the plans.
- C. Surfacing Approaches to Intersecting Roads, Driveways, and Turnouts.** For material used for surfacing approaches to intersecting roadways, driveways, and turnouts for mail boxes the contractor shall be paid the contract unit price. This payment shall be full payment for any necessary excavation incidental to this work and for furnishing, placing, and spreading the material.
- D. Base Material.** For all aggregates and soil in the base, the contractor shall be paid the contract price per ton. This payment shall be full compensation for furnishing all materials including water, and for all operations involved in the construction of the base not paid for in other items.
- E. Bituminous Material.** For bituminous material used as primer or delivered to the County for storage, the contractor shall be paid the contract price per gallon.



## DIVISION 23. SURFACE COURSES AND PAVEMENTS

Surface courses shall be constructed on prepared base courses. Pavements shall be constructed on prepared subgrade. These surfaces shall consist of construction in accordance with the requirements specified for the various types in the following sections:

2301. Concrete Pavement.

2302.

2303.

2304.

2305. Bituminous Surface Treatment, Inverted Penetration Type.

2306.

2307. Gravel Surfacing.

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### Section 2301. Concrete Pavement

2301.01 DESCRIPTION. Concrete pavement shall consist of a single course of Portland cement concrete of the full depth of the pavement and of the type covered by the contract as defined below. The width and vertical dimensions shall not be less than those shown on the plans.

- A. Type A concrete pavement shall consist of concrete mixed in the proportions specified for this type which, except for incidental sections of pavement of unusual width or shape, shall be placed and consolidated by means of a mechanical finishing machine and a mechanical vibrator capable of vibrating the entire width of the strip of pavement being placed, at each passage of the vibrating equipment moving in a direction parallel to the centerline of the pavement.
- B. Type B concrete pavement shall consist of concrete mixed in the proportions specified for this type, placed and consolidated by methods other than those prescribed for Type A concrete pavement.
- C. Standard concrete pavement shall consist of concrete mixed in the proportions specified for this type, placed and consolidated in accordance with the methods prescribed for Type A concrete pavement.



**2301.02 MATERIALS.** All materials used shall conform to the requirements of Part IV, Materials. The use of types of cement other than Type I will not be required unless so stipulated in the Special Provisions. Unless otherwise specified all types of cement will be used in the same proportions and in the same manner. Air entraining cement will not be used unless required by the Special Provisions and only as provided in such Special Provisions.

**2301.03 CONCRETE MIXER.** The concrete mixer shall be of the batch type and shall be equipped with an approved device for timing each batch. All mixers shall be maintained in good working condition. No mixer shall be used if its drum is not clean or if the effective height of its mixing blades or discharge buckets is reduced by more than 10% of their original height. For the purpose of calibrating its water measuring equipment, there shall be with each mixer a suitable connection with hose which can be substituted for a part of the discharging pipe from the water measuring tank.

**2301.04 BATCH TRUCKS.** Trucks used for transporting proportioned dry batches to the mixer shall conform to the following requirements:

Single batch bodies, or batch compartments, which will remain in a substantially level position until ready to be dumped, shall have a capacity, by water measurement, equal to at least 175 per cent of volume of concrete to be produced by the batch. Batch compartments of multiple batch trucks which must retain their batches while others are being dumped from the same truck shall have a capacity, by water measurement, equal to at least 200 per cent of the volume of the concrete to be produced by the batch.

All sides, bottoms, tailgates and partitions between compartments of truck bodies shall be of metal, preferably in one piece for their full area, but if sideboards or build-ups are necessary to obtain the required body capacity, such additions shall also be of metal, or of wood with a smooth-fitting metal lining. Such lining shall be so formed as to provide a vertical flange at least one inch deep along the lower edge of its inner face to match closely inside the inner face of the part next below, as a cover for the crack. Bodies shall have no unstopped cracks or bolt holes, and tailgates and partitions between compartments shall make a cement tight fit when in position. All interior faces of each compartment shall be free



from pockets or projections that may retain cement of the batch being dumped. Losses of cement due to any or all of these causes, which are larger than the tolerance allowed in scale accuracy will be cause for removal of the truck from the work until repaired. Latches intended to lock tailgates and partitions in position shall be positive in action. Batches whose proportions have been changed due to the failure of latches to function, shall not be used.

Unless the compartment containing the batch is fitted with a rigid tight cover, the following shall apply.

Each truck body or batch compartment shall have a top area sufficient to permit the cement to be loaded without covering all the sand. Sufficient sand shall be left exposed in each batch to permit covering the cement of that batch to a depth of approximately one inch, and such covering shall be done before the batch leaves the plant. Canvas or burlap covers are not to be regarded as substitutes for the above, but the Contractor shall have the privilege of using waterproof covers as protection against loss by rain.

To insure against loss of cement due to splash while loading, all batch trucks to be charged with cement at any one cement loading hopper shall be uniform in height from driveway to top edge of body wall, within a tolerance of 6 inches from highest to lowest body.

Truck bodies shall be kept clean and free from rust or accumulations of material and in condition to discharge the materials rapidly and completely. The Engineer shall have the right to vary the order of loading or position of the various materials in the truck body or compartment when necessary to prevent gumming or clogging the truck body or mixer skip.

**2301.05 SIDE FORMS.** Side forms shall have a height, without horizontal joint, at least equal to the designed thickness of the pavement at its edge, except that where integral curb is required the additional height represented by the curb may be secured by bolting extra forms upon the top of the main form.

Flexible or curved forms of proper radii shall be used for curves having radii of 100 feet or less.

Forms that are bent, twisted, warped or broken or forms that have battered or splintered top faces shall be removed from the work. Repaired forms shall not be used until they have been inspected and approved by the Engineer.



The top face of a form shall not vary from a true plane by more than  $\frac{1}{8}$  inch in 10 feet and the upstanding face shall not vary from a true plane by more than  $\frac{1}{4}$  inch in 10 feet.

A. Forms that are to be required to support a mechanical finishing machine, a mechanical subgrader or similar heavy equipment shall be made of steel not thinner than U. S. Standard 5 gauge (approximately  $\frac{7}{32}$  inch). They shall be equipped with a device for holding abutting sections firmly in alignment, which device shall permit adjustment for horizontal and vertical curves. Forms having a height of 8 inches or more shall have a base not less than 8 inches wide. Forms having a height less than 8 inches shall have a base width not less than their height. They shall be equipped with not less than 3 staking points per each 10 feet of length with means for securely locking the form to each stake. Flange braces and staking pockets shall extend outward on the base not less than  $\frac{2}{3}$  the height of the form.

B. Forms that are not to be required to support a mechanical finishing machine, a mechanical subgrader or other similar heavy equipment may be made of wood or of steel. They shall have sufficient stiffness and be so staked as to remain truly vertical and true to line and grade during the placing and finishing of the concrete. Straight wood forms shall have a thickness not less than  $1\frac{5}{8}$  inches. All wood forms shall be dressed on the side supporting the concrete and on their upper edge.

**2301.06 WATER SUPPLY EQUIPMENT.** The water supply equipment shall be of such capacity and nature as to insure an ample supply and a sufficient pressure for all the requirements of the work. The pipe lines shall have an inside diameter not less than 2 inches. Where pumping is necessary, duplicate pumping equipment shall be installed to insure against breakdowns.

**2301.07 ELEVATED BINS.** Before beginning the construction or erection of elevated bins for concrete materials, the Contractor shall submit to the Engineer detailed plans in triplicate showing all construction details of the elevated bins and their supporting framework and foundations. For structural steel bins or bins of other materials which have been fabricated prior to being delivered to the work, the three sets of detailed plans shall include shop drawings in such detail that a com-



plete stress analysis can be made of all structural members and connections of the bins. For ordinary conditions, soil foundation pressures, including pressure due to wind load shall not exceed one ton per square foot. These plans shall be checked by the Engineer and shall be modified as required to meet his approval. The bins shall be constructed and erected to conform to the plans thus approved. Bins shall not be subjected to loads such as those imposed by the thrust of piles of aggregate unless such loads were indicated on the approved plans.

The upper area of all compartments of aggregate bins shall be protected by substantial grillages having openings not larger than 8 inches square.

#### **2301.08 PROTECTION AND HANDLING OF AGGREGATE.**

Aggregates shall be so stored and handled as to avoid contamination. Fine and coarse aggregate shall be stored in piles which are kept entirely separated. Coarse aggregate and un-screened gravel shall be piled in horizontal layers not more than 4 feet in depth to minimize the segregation of particles of various sizes.

Aggregates shall be so handled as to avoid frequent variations in the specific gravity, sieve analysis or moisture content of the materials used. The number of changes from one material to another having a different specific gravity or sieve analysis during a working day shall be reduced to a minimum which the Engineer considers practical. The Engineer may require such methods of handling aggregates as will prevent variations of more than 0.5% in the moisture content of successive batches. Coarse aggregate having an absorption greater than 0.5% shall be thoroughly wetted at least one hour before being used.

#### **2301.09 STORAGE AND PROTECTION OF CEMENT.**

Suitable provision shall be made to prevent the loss of cement during handling.

Cement stored on the work shall be kept in a suitable weather proof building. No cement which has developed lumps in storage shall be used until it has been carefully screened through a 20 mesh sieve, to remove all lumps, and has been retested and approved.

**2301.10 SUBGRADE.** The subgrade shall be prepared as specified in Section 2109.



**2301.11 SETTING AND REMOVAL OF SIDE FORMS.**

Forms shall be set accurately to the required grade and alignment and shall be so founded and secured as to maintain that grade and alignment while the concrete is being placed and finished and until such time as they may be removed. Forms shall be set on properly compacted materials. If the form is to support a mechanical finisher, a mechanical subgrader or similar heavy equipment, any excavation required to shape the subgrade for the form shall be made by means of a machine designed for this specific purpose and approved by the Engineer.

Except as provided below, forms shall be set with the base and top of the form at the respective designed elevations of the subgrade and the finished surface of the pavement at its edge.

With the specific approval of the Engineer, forms having a height greater than the designed thickness of the edge of the pavement may be used when set as follows:

- (1) The form may be set with its top at the design elevation of the finished surface of the pavement and the base at an elevation lower than the design subgrade elevation, provided the subgrade for the pavement is excavated to meet the lower edge of the form with a straight lateral slope not steeper than 3 inches vertical to 1 foot horizontal. All additional excavation and concrete required by this method shall be at the Contractor's expense.
- (2) Forms for pavement not required to be struck off with a mechanical finishing machine and on which integral curb is required, may be set with the base of the form at the designed subgrade elevation and the top above the designed elevation of the finished surface of the pavement. Special care shall be taken to remove all water and laitance from the edge of the pavement before concrete for the curb is placed.

After forms are set and locked they shall be tamped on both sides of each form throughout its entire length with a tool of suitable design and weight. This tamping shall force suitable material into intimate contact with the base of the form. Should the earth supporting the form become softened by rain or standing water so that the form is not adequately supported the form shall be reset on suitable material before concrete is placed. After the forms have been set the joints shall be checked with a straight edge at least 10 feet long and corrected to proper grade and alignment.



Forms shall be cleaned and oiled before concrete is placed against them. Side forms shall be left in place not less than 15 hours after the concrete is placed. Curb forms shall remain in place not less than 6 hours after the concrete is placed. Care shall be exercised in the removal of forms to prevent cracking, spalling or over stressing the concrete. When forms are removed by means of equipment operating on the pavement surface all stakes shall be removed before the form is raised.

**2301.12 PROPORTIONS FOR CONCRETE MIXTURES.** The concrete mixture used shall conform to the following requirements for the type of concrete pavement specified in the contract.

**A. Type A Concrete Pavement.** The concrete used for Type A concrete pavement shall conform to one of the following proportions:

Mix No.	BASIC ABSOLUTE VOLUMES OF MATERIAL PER UNIT VOLUME OF CONCRETE			
	Cement Minimum	Water Approximate	Fine Aggregate Approximate	Coarse Aggregate Approximate
1A	0.089840	0.148531	0.268976	0.495653
2A	0.091312	0.152662	0.302410	0.453616
3A	0.093763	0.156760	0.337332	0.412145
4A	0.096419	0.161201	0.371190	0.371190

The total volume of free water in the concrete, including the water in the aggregate, shall not exceed 6.25 gallons of water per bag of cement (0.554632 pounds per pound; 0.8355 cubic feet per bag of cement).

Mix No.	APPROXIMATE QUANTITIES OF DRY MATERIALS PER CUBIC YARD OF CONCRETE		
	Cement	Fine Aggregate	Coarse Aggregate
1A	1.25 bbl. (470 lb.)	0.596 tons	1.1065 tons
2A	1.28 bbl. (483 lb.)	0.675 tons	1.0125 tons
3A	1.32 bbl. (496 lb.)	0.753 tons	0.9200 tons
4A	1.36 bbl. (510 lb.)	0.8285 tons	0.8285 tons

These quantities are based on the following assumptions:

Specific gravity of cement—3.14.

Specific gravity of aggregate—2.65.

Water-cement ratio—6.0 gallons of water per bag of cement.

Weight of 1 cubic foot of water—62.4 lb. and that the fresh concrete contains no air voids.

**B. Type B Concrete Pavement.** The concrete used for Type B concrete pavement shall conform to one of the following proportions:



Mix No.	BASIC ABSOLUTE VOLUMES OF MATERIAL PER UNIT VOLUME OF CONCRETE			
	Cement Minimum	Water Approximate	Fine Aggregate Approximate	Coarse Aggregate Approximate
1B	0.115873	0.169510	0.235824	0.478793
2B	0.121544	0.177806	0.280260	0.420390
3B	0.126459	0.184996	0.309845	0.378700
4B	0.131562	0.192462	0.337988	0.337988

The total quantity of free water in the concrete, including the water in the aggregate, shall not exceed 5.5 gallons of water per bag of cement (0.488076 pounds per pound; 0.73524 cubic feet per bag).

Mix No.	APPROXIMATE QUANTITIES OF DRY MATERIALS PER CUBIC YARD OF CONCRETE		
	Cement	Fine Aggregate	Coarse Aggregate
1B	1.63 bbl. (613 lb.)	0.5265 tons	1.0690 tons
2B	1.71 bbl. (643 lb.)	0.6255 tons	0.9385 tons
3B	1.78 bbl. (669 lb.)	0.6915 tons	0.8455 tons
4B	1.85 bbl. (696 lb.)	0.7545 tons	0.7545 tons

These estimated quantities are based on the following assumptions:

Specific gravity of cement—3.14.

Specific gravity of aggregate—2.65.

Water-cement ratio—5.25 gallons of water per bag of cement.

Weight of one cubic foot of water—62.4 lb. and that the concrete contains no air voids.

C. Standard Concrete Pavement. The concrete used for standard concrete pavement shall conform to one of the following proportions:

Mix No.	BASIC ABSOLUTE VOLUME OF MATERIAL PER UNIT VOLUME OF CONCRETE			
	Cement Minimum	Water Approximate	Fine Aggregate Approximate	Coarse Aggregate Approximate
1C	0.105620	0.155975	0.258047	0.479358
2C	0.109446	0.160109	0.292178	0.438267
3C	0.113794	0.166468	0.323882	0.395858
4C	0.117952	0.172552	0.354748	0.354748

The total quantity of free water in the concrete, including the water in the aggregate shall not exceed 5.634 gallons of water per bag of cement (0.500 pounds per pound; 0.75320 cubic feet per bag).

Mix No.	APPROXIMATE QUANTITIES OF DRY MATERIAL PER CUBIC YARD OF CONCRETE		
	Cement	Fine Aggregate	Coarse Aggregate
1C	1.50 bbl. (564 lb.)	0.5760 tons	1.070 tons
2C	1.54 bbl. (579 lb.)	0.6520 tons	0.9785 tons
3C	1.60 bbl. (602 lb.)	0.7230 tons	0.8835 tons
4C	1.66 bbl. (624 lb.)	0.7920 tons	0.7920 tons



These quantities are based on the following assumptions:

Specific gravity of cement—3.14.

Specific gravity of aggregate—2.65.

Water-cement ratio—5.25 gallons of water per bag of cement.

Weight of one cubic foot of water—62.4 lb. and that the fresh concrete contains no air voids.

**2301.13 ADJUSTMENT OF PROPORTIONS.** The estimated quantities of cement per cubic yard of concrete shown in the tables above are based on average conditions. If the combination of materials used is such that the quantity of cement required is consistently more than 101 per cent or less than 99 per cent of the estimated quantity, the proportions will be adjusted accordingly. This provision does not apply to variations in quantities caused by variations in the dimensions of the pavement slab.

**2301.14 PIT RUN OR UNSCREENED GRAVEL.** If the use of pit run or unscreened aggregate is approved, the proportions will be fixed upon the basis of the relative amounts of fine and coarse aggregate contained so as to be equivalent to one of the appropriate mixes specified above for screened aggregate. Attention is directed to the conditions under which pit run aggregate may be used as specified in Article 4107.07.

**2301.15 QUANTITY OF MIXING WATER AND CONSISTENCY OF CONCRETE.** The amount of mixing water used shall be that which will produce concrete of uniform consistency adapted to the mix and kind of materials being used, the methods of consolidation and the slope of the finished surface. Except as specifically modified by the Engineer the slump measured in accordance with A.S.T.M. Method of Test D-138 shall be within the following limits:

Type of Pavement	Slump — Inches	
	Minimum	Maximum
Standard or Type A	$\frac{1}{2}$	$1\frac{1}{2}$
Type B	1	$2\frac{1}{2}$

In case the combination of materials furnished is such that the specified degree of workability is not produced with the maximum water-cement ratio specified in Article 2301.12, the proportion of cement to aggregate shall be increased to produce the specified degree of workability with the specified maximum water-cement ratio. In the case of such adjustment the provisions of Article 2301.13 shall not apply.



**2301.16 MEASUREMENT OF MATERIALS.**

- A. **Cement.** Cement shall be measured by weight upon approved scales which shall be accurate to 0.2 per cent at all loads, except that cement in unopened bags as packed by the manufacturer may be considered to weigh 94 pounds per bag. Scales for weighing cement in a closed compartment shall be equipped with an independent tare beam and the scale shall be balanced to the tare after each batch is discharged.
- B. **Water.** Water shall be measured with equipment which is accurate to one quart. Tanks for measuring water by volume shall not be fed directly from a pressure line but from an auxiliary tank having a volume at least equal to that of the measuring tank. The equipment shall be so arranged that the pressure in the measuring tank cannot exceed that due to the difference in elevation of the two tanks.
- C. **Aggregates.** Aggregates shall be weighed on approved scales which shall be accurate within 0.2 per cent at all loads. The weighing equipment shall comply with the following conditions:
1. At least that part of the total load weighed which is a fraction of 100 pounds shall be indicated on a graduated beam or dial.
  2. The weighing equipment shall be so arranged that when operating the bin gates the operator stands in such a position that the weighing beam or dial is in full view and he can conveniently shovel material from the weighing hopper.
  3. There shall be enough clearance at the top of the weighing hopper to permit the scale operator to shovel material out of the weighing hopper or suitable openings shall be provided in the side of the hopper for this purpose.
  4. Weighing hoppers on platform scales shall be mounted so that the center of gravity of the weighing hopper, both loaded and unloaded, is vertically over the center of the scale platform.
  5. Weighing equipment, if equipped with graduated beams, shall have an independent weighing beam for each class or separate size of material to be weighed on the scale.



6. The contractor shall provide each installation of weighing equipment with at least 8 standard 50-pound test weights for the purpose of testing and calibrating weighing equipment. The test weights shall be kept clean and shall be used for no purpose other than the testing and calibrating of weighing equipment.

**2301.17 MIXING CONCRETE.** Concrete shall be mixed in a mixer of the batch type. The method of handling the batches and charging the mixer shall insure the complete introduction of each batch separately without loss of materials. The discharge portion of the mixing cycle shall be so regulated that the volume of concrete from any batch remaining in the mixer drum will not exceed 10 per cent of the maximum size of batch herein specified for that mixer. If this portion of the mixing cycle cannot be so adjusted, the size of batch shall be reduced until the batch will discharge within the foregoing limit within the discharge portion of the cycle. Water shall be introduced at the same time as the other materials.

The total volume of batch shall not exceed the following for the mixers specified:

Size Designation of Mixer	Volume of Batch, Cubic Feet
27E.....	29.7
34E.....	37.4

The size designations shall be those prescribed in the Concrete Mixer Standards, Eighteenth Revision, Twenty-second Year, Adopted by the Mixer Manufacturers Bureau of the Associated General Contractors of America, Inc., May 2, 1946. Approved by the Associated General Contractors of America, Inc., July 2, 1946.

The concrete as discharged from the mixer shall be uniform in composition and consistency. If this condition is not produced with the maximum size of the batch, the size of the batch may be reduced or the mixing time increased, or both, until this result is obtained. The mixing shall continue for a minimum of one minute after all the solid ingredients are in the drum, during which time the drum shall revolve at the speed for which it was designed, but not less than 12 nor more than 18 revolutions per minute.

**2301.18 READY-MIXED CONCRETE.** Ready-mixed concrete may be used in lieu of concrete mixed at the site of the work. The term "ready-mixed concrete" shall be construed to include both central plant-mixed concrete or truck-mixed con-



crete. Central plant-mixed concrete shall be construed to mean concrete mixed in a stationary mixer with or without mechanical agitation in the transporting vehicle. Central plant-mixed concrete shall be mixed in accordance with the provisions of Article 2301.17. Truck-mixed concrete shall be construed to mean concrete partly or wholly mixed in the transporting vehicle.

A. **Transporting Concrete.** Vehicles for transporting concrete shall have such capacity and be so constructed as to insure against loss of any of the ingredients of the concrete and to insure rapid discharge of the concrete.

The concrete at the time of delivery shall be uniform in composition and of the specified consistency. Concrete in which the cement has been placed in contact with the aggregate more than  $1\frac{1}{2}$  hours before the time it is delivered to the work shall not be used. Under no circumstances shall partially hardened or retempered concrete be used. The compartment in which the concrete is transported to the work shall be thoroughly cleaned and flushed with water before receiving each batch. The Engineer may require that such compartments be fitted with suitable covers to prevent evaporation and to exclude foreign material. Such covers shall be kept closed from the time the concrete is introduced until it is discharged.

B. **Delivery.** Ready-mixed concrete may be delivered only by an organization which will assign to the work sufficient plant capacity and transporting equipment to insure delivery at the rate required to insure the efficient and proper handling, placing and finishing of the concrete.

The methods of delivering and handling the concrete shall be such as will facilitate placing with a minimum of rehandling and without damage to the concrete.

C. **Truck-mixed Concrete.** When a stationary mixer is used for partial mixing of the concrete, the mixing time in the stationary mixer shall be not less than is required to intermingle the ingredients but not less than 30 seconds. When a truck mixer is used either for complete mixing or to finish the partial mixing done in a stationary mixer, each batch shall be mixed not less than 50 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the mixer manu-



facturer as mixing speed. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as the agitating speed.

When a truck mixer or truck agitator is used for transporting concrete which has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as the agitating speed.

**D. Size of Batches for Truck Mixers.** The volume of mixed concrete in each batch shall conform to the following:

1. When used for complete mixing the size of batch for top door loading truck mixers shall not exceed the manufacturer's rating nor shall it exceed 50 per cent of the gross volume of the drum.
2. When used for complete mixing the size of batch for end loading truck mixers shall not exceed the manufacturer's rating nor shall it exceed 57.5 per cent of the gross volume of the drum.
3. When used for partial mixing the size of batch shall not exceed the manufacturer's rating nor shall it exceed 66.66 per cent of the gross volume of the drum.
4. When used for agitating only, the size of batch for a truck mixer or the truck agitator shall not exceed the manufacturer's rating nor shall it exceed 80 per cent of the gross volume of the drum.
5. The volume of batch shall be computed as the total volume of all the ingredients plus any air in excess of 5 per cent that may be entrained. The manufacturer's rating shall be construed to mean the various volumes for various uses as shown on a plate affixed to the mixer by its manufacturer.

**2301.19 PLACING CONCRETE.** The concrete shall be deposited upon the subgrade to the full required depth of the pavement except where fabric reinforcement is required. Except as otherwise indicated on the plans the pavement shall be constructed as a single strip. The concrete along the forms shall be spaded or vibrated immediately after it is placed.

Bar reinforcement shall be firmly supported by permanent chairs or by removable transverse bar supports with handles, which supports shall lock firmly to the side forms. At least 6 removable supports which hook over the side forms shall be provided for supporting the longitudinal bars nearest the edge of the pavement.



A. **Standard or Type A Pavement.** The concrete for all sections of Standard or Type A concrete pavement that have a uniform width normal for the project for a length greater than 50 feet shall be struck off and compacted by means of an approved finishing machine which shall include a mechanically operated screed resting upon the concrete and moved upon it in such a manner as to leave the top of the concrete slab smooth and at the proper elevation. Where the plans require that pavement be laid partly with crown and partly without crown, the screed shall be so equipped that it can be adjusted to the change in shape at the required rate of change. Before the concrete is struck off or at the same time it is being struck off the concrete shall be consolidated by means of a vibrating screed or pan operating on the surface of the concrete or by means of a vibrating tube or assembly of tubes operating in the concrete. The vibrating unit shall be so designed as to vibrate the concrete for the full width of the slab at a single passage. The rate of vibration shall be not less than 3500 vibrations per minute. Sections of pavement having widths other than that normal to the project shall be placed as provided above or as provided for Type B pavement.

B. **Type B Pavement.** The concrete in all slabs not covered by a finishing machine shall be consolidated by the use of an internal vibrator which shall be manipulated throughout all available space in the concrete. Such vibrators shall be of the rotating type and shall be operated at speeds which will produce not less than 3500 vibrations per minute. The vibration shall be applied to each batch of concrete as it is deposited. The number of vibrating units furnished shall be sufficient to perform the required function at the desired rate of progress. Any concrete for Type B concrete pavement placed by means of a mechanical finishing machine shall be vibrated in the area extending 18 inches on each side of each transverse joint and throughout the area at any heavily reinforced section.

2301.20 **FINISHING TOOLS.** Before placing any concrete the Contractor shall provide the following hand-finishing tools for use during breakdowns of mechanical finishers and for finishing on widened curves, transition sections, inlets and



other irregular sections of pavement, and for use in supplementing the work of mechanical finishing machines:

- A. One 6x8 timber tamper cut to correct crown of a length to span the full width between side forms.
- B. One wooden strikeboard 2 inches thick, iron bound on the lower edge, cut to crown and of length approximately one foot greater than the full width between side forms and of sufficient rigidity to maintain its shape when in use.
- C. Two wooden floats of a size approximately one foot by three feet, with handles at least 12 feet long.
- D. Five small wooden hand floats.
- E. Three pointing trowels.
- F. Two curb mules, either metal or faced for shaping three inch integral curbs.
- G. Two light straightedges, 10 feet long mounted on handles at least 12 feet long, for use in detecting irregularities in the surface, two heavy straightedges of similar size for use in smoothing the surface, and two light straightedges 6 feet long without handles for checking curb and gutter lines.
- H. Four edgers for finishing the pavement edges, expansion joints and flumes.
- I. Two belts not less than 8 inches wide and of a length not less than the full width of the strip being finished plus two feet.
- J. One longitudinal float 12 inches wide and 12 feet long with the edges of its bottom surface rounded. It shall be equipped with two pairs of plow handles, or others of similar design, of such length that the operators may stand practically upright when working from bridges. If made of wood this float shall be 3 inches thick. If made of metal it shall have a weight approximately equal to a similar float made of 3-inch plank, and shall be lined on its bottom face with wood.
- K. Two bridges from which to operate the longitudinal float.
- L. One bridge from which to finish the transverse joints.

**2301.21 FINISHING.** After the concrete has been placed, consolidated and struck off as hereinbefore prescribed, the pavement shall be finished in the following manner:



A. A float as described in Paragraph 2301.20-J above shall be operated longitudinally over the entire surface of the pavement with a combined longitudinal and transverse motion, passing slowly from one side of the pavement to the other a sufficient number of times (at least twice), to smooth all ridges and fill all depressions, until the float on its last passage shall show contact with the concrete throughout its entire length and width. The float shall rest flat on the surface of the concrete throughout this operation, except that if a ridge be encountered which cannot be eliminated by floating, the float may be tilted so that its edge will operate as a screed to remove the excess concrete, after which the surface shall be refloated with the float in the flat position. Depressions appearing after the initial passage of the float shall be filled with additional concrete before the final passage. The float shall be operated by men working on bridges that span the full width of the pavement. In moving forward with the float each successive position shall overlap the preceding position by one-half the length of the float.

In lieu of the above process a machine which will produce an equivalent result may be used.

B. Immediately after completion of the longitudinal floating described above, the surface of the concrete shall be struck off and smoothed with the heavy ten foot straightedges set parallel to the centerline, supplemented by such hand floating as is necessary to eliminate all depressions and irregularities. High areas shall be removed, and depressions shall be filled with additional concrete. The entire area of surface that has been disturbed in making the corrections shall be immediately refinished by hand to a smooth and even surface. This striking off and correcting of the surface shall be started as soon as the condition of the concrete will permit, and the Contractor shall detail to this work a sufficient number of skilled finishers to complete the corrections before the initial set has taken place.

C. The surface of the slab shall then be given a preliminary transverse belting with a belt not less than 8 inches wide using a combined crosswise and longitudinal motion. This operation shall remove all marks of previous finishing operations and provide a surface equal in



smoothness and finish to that obtained at the final belting.

- D. After this preliminary belting the entire surface shall be checked with light straightedges set parallel to the centerline of the roadway. Successive positions of the straightedges in the direction of progress of the work shall lap one-half the length of the straightedge. All depressions and irregularities of the surface shall be corrected.
- E. After the greater part of the water-glaze has disappeared from the surface the concrete shall be given a final belting to remove all tool marks and to produce a uniform surface of a gritty texture. In order to secure the desired surface the Engineer may require that the length of stroke and the rate of advance be varied according to the aggregate used, the amount of water present, and the rate of hardening of the concrete.
- F. After the final belting, the edges of the pavement along the side forms shall be rounded in a workmanlike manner by means of a suitable edging tool.
- G. After the concrete has set sufficiently hard to bear a man's weight without injury to the surface, and before the application of the final curing process, the entire surface of the pavement will be checked by the Inspector with a surface testing straightedge of special design, which will be furnished by the Commission. In this checking process successive positions of the straightedge will overlap the preceding positions by one-half the length of the straightedge. High spots in excess of one-eighth inch on a ten foot straightedge shall be smoothed to bring the surface within this one-eighth inch tolerance. This smoothing shall be accomplished by rubbing with a carborundum brick, or by other methods which will produce equivalent results. The Contractor shall furnish the necessary men to remove and replace the burlap covers and remove all high spots encountered before the final curing process is applied.

**2301.22 INTEGRAL CURB.** At such a time in the finishing process described in Article 2301.21 as to precede the initial set in the concrete of the main paving slab (generally immediately following 2301.21 E), any integral curb required shall be constructed.



Unless otherwise provided by the detailed plans, steel curb forms as specified in Articles 2301.05 and 2301.11 will be required to form the back of all curbs, except where street returns of small radius or other special sections make the use of standard steel forms impractical.

Sloping faced highway curb of three inch height will not require face forms, but will be shaped to the desired cross section with the curb mule specified in Article 2301.20. Curbs of a height greater than three inches will require face forms of a type to produce curb of the cross section shown on the plans, except that approved hand shaping methods may be used to supplement the forms in shaping the top roll of ogees, and on returns and other special sections. The face forms may be of either wood or steel but must be sufficiently rigid to maintain their position and shape during use. Back forms for curb shall be rigidly attached to the side forms of the paving slab, using all the fastenings provided by the manufacturer. They shall extend the plane of the side forms without variation of more than one-eighth inch. The top of the side form shall be free of concrete or any other matter that would prevent rigid fastening or accurate alignment when curb forms are attached.

Before concrete for the curb is placed, any free water, laitance, dust, leaves or other foreign matter which may have collected on the edge of the slab shall be removed. Concrete for the curb shall be freshly mixed and in a plastic, workable condition. The practice of storing concrete in receptacles on the side of the road as the mixer passes, for use in the curb at a later time, will be permitted only under weather conditions, usually spring and fall, which do not cause deterioration in the concrete.

Concrete which has dried or partially hardened or requires retempering shall not be used.

In placing curb concrete sufficient puddling shall be done to secure adequate bond with the paving slab and eliminate rock pockets in the curb, but care shall be used to avoid disturbing the position or alignment of forms or causing upheavals of concrete in the line of the finished gutter.

The final finish on three inch sloping highway curb may be secured with the curb mule, or it may be supplemented by the use of hand floats, damp brushes, etc. The resulting surfaces of both curb and gutter shall be checked by the use of the ten foot straightedge and corrected if necessary. The final finish on higher curbs will be secured by hand methods, including



the six foot straightedge, after the removal of the face forms. In removing face forms care shall be used to avoid slumps or the disturbance of partially set concrete. The work of constructing integral curb shall proceed as rapidly as the finishing operations on the paving slab will permit and in all cases shall be completed in the same working day that the slab is placed, except for the length of section required at the end of the day's run to accommodate the finishing machine. In the section left for subsequent placement of curb the surface of the paving slab along the line of the inside slope of the curb shall be depressed so that the new concrete placed for curb shall not be less than  $1\frac{1}{2}$  inches thick. This section of curb shall be doweled to the slab by hooked steel bars  $\frac{3}{8}$  inch in diameter spaced at one foot intervals. The surface of the slab back of the key notch shall be roughened and a depression created around each dowel so that it will project at least two inches into the curb concrete.

All curbs shall be edged, protected, and cured the same as other parts of the paving slab.

**2301.23 END OF RUN.** Whenever 30 minutes or more have elapsed since the delivery of the last concrete to the subgrade or if such a delay is anticipated, a header shall be installed. The header shall be shaped to fit the cross section of the pavement and so placed that its upper edge will conform to the crown of the pavement. It shall be installed on the subgrade perpendicular to the surface of the pavement and at right angles to the centerline of the pavement. The header shall be provided with holes through which the required dowels shall be passed. The diameter of the holes shall be one-half inch greater than the diameter of the dowels. It shall be provided with such supports as may be necessary to insure that it will remain true to line and grade during the placing and finishing of the concrete. The concrete shall be well spaded against the header and finished with an edging tool. Care shall be taken in removing the header to avoid disturbing the dowels or the concrete. The exposed ends of the dowels shall be greased with a material not less viscous than heavy transmission grease.

When the delivery of concrete is resumed it shall be placed against the exposed face of the previously placed concrete, thoroughly vibrated and finished with an edging tool. Unusual care shall be taken to insure that the concrete at the beginning of a run is of the proper composition and consistency.



**2301.24 PROTECTION AND CURING.** After the final belting, the concrete shall be protected by a covering of thoroughly wetted burlap applied as soon as it is possible to do so without marring the surface. During its application the burlap shall not be dragged over the concrete or over burlap that has been previously placed. This covering shall remain in place for at least 20 hours during which time it shall be kept continuously wet by means of a spray of water fine enough to avoid damage to the concrete.

Other fabrics or mats complying with and used in accordance with the provisions of Paragraph E may be used in lieu of burlap.

Following the period of protection with burlap the concrete shall be given the curing treatment prescribed in one of the following paragraphs except that:

(1) "Curing with Calcium Chloride Admixture" may be required by the Engineer after October 15, and this method of curing shall not be used between May 1 and October 15;

(2) That black impervious coatings shall not be used on strips of pavement constituting less than the full contemplated width of the pavement, or on pavements with curb having a normal height greater than 3 inches; and

(3) Type A concrete pavement shall be cured in accordance with the provisions of Method "A," "Curing with Wet Earth, Sand, Straw or Hay" or in accordance with Method F, "Ponding."

**A. Curing with Wet Earth, Sand, Straw or Hay.** As soon as the burlap is removed the surface of the pavement shall be covered with at least two inches of earth or sand, or with at least six inches of hay or straw. The cover used shall be kept continuously wet until seven days after the concrete was placed. If the earth protecting the edges of the slab is not kept thoroughly wetted, the Engineer may require that these edges be given an impervious coating as specified in Paragraph 2301.24-C.

**B. Curing with Calcium Chloride Admixture.** Calcium Chloride shall be incorporated in the concrete in a quantity equal to 2 pounds of calcium chloride per 100 pounds of cement. The calcium chloride may be added as a solution measured as a part of the mixing water. The ratio of water to calcium chloride in the solution shall be as directed by the Engineer.



Mechanical devices satisfactory to the Engineer shall be provided for mixing the calcium chloride and water and for introducing the solution into the mixer in the exact amount required for each batch. The calcium chloride solution shall be introduced with the remainder of the mixing water. Calcium chloride in flake form may be added to the solid materials just before they are placed in the mixer. In this case the quantity of calcium chloride required for each batch shall be carefully weighed and shall be so handled as to avoid any tendency to cause materials to stick in skips or other charging equipment. The Engineer may require such increase in mixing time as may be necessary to insure that the calcium chloride will be completely dissolved and thoroughly dispersed throughout the batch. After the final belting the concrete shall be protected for at least 48 hours in the manner prescribed in Paragraph E, "Curing With Wet Burlap or Other Fabric Mats."

- C. **Curing With Impervious Coatings.** As soon as the burlap is removed, the top surface and the edges of the pavement shall be covered with a continuous, uniform, water-impermeable coating. If the impervious coating has a color darker than the uncoated concrete, the coated surface of the concrete shall be covered with an additional coating of whitewash made from hydrated lime and water, or a mixture of hydrated lime, powdered limestone and water approved by the Engineer, applied within two hours after the time the impervious coating was applied. The proportions used in the whitewash and the rate of its application will be such as will produce on the surface of the pavement a uniform white color.

The impervious coating shall comply with the requirements of Section 4147.

- D. **Curing With Paper.** As soon as the burlap is removed, the top surface and the edges of the pavement shall be thoroughly wetted with water and immediately covered with a layer of paper. At the junction of units of paper the units shall be lapped at least 18 inches. The paper shall be so placed and weighted as to cause it to remain in intimate contact with the surface covered. The paper shall remain in place until seventy-two hours after the concrete was placed. The paper used for this purpose shall comply with the requirements of Section 4145.



**E. Curing With Wet Burlap or Other Fabric or Mats.** After the final belting the concrete shall be protected with a covering of at least two thicknesses of burlap specified in the foregoing paragraphs for at least seventy-two hours. When the side forms are removed the edges of the slab shall be covered with burlap as specified for the protection of the top surface of the pavement. The burlap used for the protection of the top surface of the pavement shall be sufficiently long to extend to the bottom corners of the slab.

In lieu of the covering of burlap specified, the concrete may be covered with other fabrics or mats approved by the Engineer. Such coverings shall be capable of preventing the evaporation of mixing water and controlling variations in the temperature of concrete to a degree at least equal to that of two thicknesses of burlap, complying with these specifications, kept continuously wet.

At the time such coverings are applied the surface of the covering to be placed in contact with the concrete shall be thoroughly wet.

Wetting subsequent to the application of the covering shall be that required by the Engineer to produce the desired results as indicated by the tests outlined above.

Tests for the control of the evaporation of mixing water shall be conducted as outlined in Article 4147.06 except that the test period shall be seventy-two hours. Tests for the control of variations in temperatures shall be conducted under direct sunlight.

**F. Curing by Ponding.** As soon as the burlap has been removed the surface of the pavement shall be covered for not less than forty-eight hours with water to a depth of not less than  $\frac{1}{2}$  inch at the shallowest point. The water shall be held by dikes of earth built on the surface of the pavement. Earth for this purpose shall not be taken from the shoulders below the elevation of the bottom of the pavement.

**G. Protection.** When, during daylight hours, the air temperature falls below 45°F. all other methods of curing, except the burlap covering prescribed for protection during the first twenty hours, shall be discontinued and the surface of all pavement less than thirty-six hours old shall be covered with a uniform layer of straw not



less than 6 inches thick. The straw shall be adequately protected from disturbance by wind. On fresh concrete a layer of burlap shall be placed between the concrete and the straw. The straw covering shall remain in place until the pavement may be opened to the Contractor's forces in accordance with Article 2301.27.

Regardless of the method of curing used the vertical faces of the pavement, except those against which the Contractor is to place concrete, shall be protected by a covering of earth to the full depth of the slab and placed as soon after the removal of the forms as the method of curing will permit or weather conditions will warrant. No earth for this protection shall be taken from the shoulders below the elevation of the bottom of the pavement.

**2301.25 RESTRICTIONS OF OPERATIONS AS AFFECTED BY WEATHER.** Concrete shall not be placed when stormy or inclement weather will prevent good workmanship. No aggregates containing frozen lumps may be used, and concrete shall not be placed on a frozen subgrade. If weather conditions are favorable concreting operations may be started when the temperature of the concrete as delivered to the subgrade is 40°F. or higher and may proceed so long as this temperature requirement is met and the air temperature remains above 38°F. Concrete placed when the air temperature is below 45°F. shall be covered with burlap and at least 6 inches of straw before the completion of the day's operation.

**2301.26 NIGHT OPERATIONS.** Concrete shall not be placed when darkness would prevent good workmanship in placing and finishing operations. Unless otherwise specifically approved by the Engineer placing and finishing operations under artificial light will not be permitted, and the work shall be organized accordingly.

**2301.27 TIME FOR OPENING PAVEMENT FOR USE.** The time for opening pavement for use will be based on the strength of the concrete as determined from beam specimens made during the progress of the work. The pavement may be opened to the Contractor's forces for the purpose of removing coverings and building shoulders as soon after the minimum age period specified below as tests of beams for that section show a modulus of rupture of 500 pounds or more per square inch.



Type of Pavement	Kind of Cement	Minimum Age
Type A	Normal Portland	14 Days
Type A	High Early Strength	7 Days
Standard or Type B	Normal Portland	7 Days
Standard or Type B	High Early Strength	3 Days

General traffic may be allowed upon the pavement as soon thereafter as the pavement is in condition for safe use.

**2301.28 TRANSVERSE JOINTS.** Transverse joints shall be installed as shown on the plans. They shall be installed perpendicular to the surface of the pavement and at right angles to its centerline unless otherwise shown on the plans. They shall be of the type and material shown on the plans. The ends of dowel bars through expansion joints shall be fitted with metal expansion tubes as specified in Article 4149.02.

The portion of the expansion joint which extends through the curb shall be twice the thickness of the joint in the pavement slab. Care shall be taken to insure that the joint in the curb is centered directly over the joint in the pavement slab.

Before any earth or sand is placed on the surface of the pavement in the curing operation, in the process of building shoulders or by traffic, expansion joints shall be sealed with the material specified for that purpose.

Care shall be taken to fill the joints flush with the top of the pavement without spilling sealing material on the pavement surface.

The sealing material shall be heated in a heater of such size and design that it will not subject the concrete to abrasion, excessive loads or excessive heat.

**2301.29 LONGITUDINAL JOINTS.** Longitudinal joints shall be constructed as shown on the plans. Such joints shall be true to line. They shall be constructed by installing a metal parting strip or by the employment of some method or device which will result in the creation of a definite plane of weakness extending into the slab not less than the dimension shown on the plans. Any method or device for creating a plane of weakness shall be of a mechanical nature to insure a straight, workmanlike installation, and shall be subject to the approval of the Engineer before being used. Any method or device using premoulded bituminous parting strip shall be capable of continuous operation. The strip installed shall be continuous between transverse joints, and shall conform to the dimensions shown on the plans. When the plane of weakness is made by installing a metal form to be removed after the



concrete has set, the sections of metal form shall be provided with interlocking ends and shall be sufficiently rigid to hold themselves in position. The sections shall be removed from the set concrete the following day and the opening filled with bitumen.

Material used for longitudinal joints shall comply with the requirements of Article 4149.01.

**2301.30 CONCRETE RESURFACING.** When the contract involves placement of new concrete wearing surface on an old concrete base, the old asphalt or brick wearing surface shall be removed from the old base to the extent indicated on the plans, except that old asphalt surfacing which adheres tightly to the old base and is far enough below the grade of the finished surface that the resurfacing will have the full specified thickness, need not be removed. The base shall be thoroughly cleaned of all loose or foreign material and unless the plans require base to be covered with subgrade paper, it shall be kept continuously wet for at least one hour prior to placement of the resurfacing. Portions of the old base which are badly broken or disintegrated shall be removed and patched with new concrete before the resurfacing is placed. These patches shall be protected and cured with wet burlap as specified in Paragraph 2301.24-E, except that small patches which will not be subjected to truck traffic may be placed not less than twenty-four hours in advance of placing the resurfacing.

**2301.31 CONCRETE HEADERS.** Concrete headers shall be constructed of the same class of concrete as that specified for the pavement. Concrete headers shall be constructed as ordered by the Engineer and in conformance with the Standard plan.

**2301.32 FIXTURES IN PAVEMENT SURFACE.** All manholes, catch basins, valve holes or other fixtures encountered within the area to be paved shall be adjusted to conform to the finished surface of the pavement to be built. Premoulded expansion joint material at least  $\frac{3}{2}$  inch thick and a width not less than the thickness of the pavement shall be placed around each fixture to completely separate the fixture from the concrete.

**2301.33 SHOULDERS.** Earth shoulders shall be constructed as provided in Section 2110.

**2301.34 METHOD OF MEASUREMENT.** The area of pavement in square yards and the amount of curb or combined curb



and gutter in lineal feet of single curb will be computed by the Engineer from measurements of the finished pavement. For pavement with integral curb the measurements for area of pavement will extend from back to back of curb. For separate curb and gutter and integral curb the number of lineal feet will be determined by measuring along the face of the curb at the mid-height. No deduction will be made for flume and catch basin openings.

The volume of concrete in resurfacing and in extra concrete for headers and other incidental construction will be determined by multiplying the number of batches of concrete placed by the absolute volume of all materials, including water, entering the average batch.

Where the contract includes a price per cubic yard for excavation, the excavation required for the preparation of natural subgrade will be measured as provided in Article 2102.12, except that the volumes measured for payment will include only the materials actually removed above the elevation of the pavement subgrade and between vertical planes one foot outside the edges of the finished pavement. No other work connected with the preparation of natural subgrade will be measured for payment.

The number of stations of earth shoulder finished will be measured as provided in Section 2110.

**2301.35 BASIS OF PAYMENT.** The contract price per square yard for constructing the pavement, and per cubic yard for the earth in connection therewith, shall be full payment for the furnishing of all materials not specifically omitted from the contract, and all tools, equipment, labor and supplies that are necessary to construct the pavement, including the earth shoulders and side ditches complete in accordance with the plans and specifications except as follows:

- A. The Contractor shall furnish not to exceed two cubic feet of concrete per day for test specimens without additional compensation.
- B. For concrete resurfacing where the actual volume of concrete placed per square yard will vary because of variations in thickness of the slab the concrete will be paid for at the contract price per cubic yard.
- C. Concrete for headers and other extra items incidental to the pavement construction will be paid for at the contract price per cubic yard for "extra concrete." When the quantity of extra concrete involved is small



and no unit price for this item has been provided in the contract, the price per cubic yard for extra concrete shall be obtained by multiplying the price per square yard of concrete pavement by 5.0.

- D. For finishing the earth shoulders measured as provided above, the Contractor will be paid the contract price per station.
- E. When integral curb, separate curb, or combined curb and gutter is required, the number of lineal feet of integral curb, separate curb or combined curb and gutter, measured as provided above, will be paid for at the contract price per foot therefor.
- F. No deduction from the yardage of pavement will be made for fixtures with an area of nine square feet or less. When the adjustment of the fixtures to the finished grade line involves a change in elevation of one foot or less, such adjustment of fixtures shall be made without extra compensation. If adjustment of the fixtures to the finished grade requires a change in elevation of more than one foot such work shall be paid for as an extra as provided in Paragraph 1109.04-B.

### Section 2305. Bituminous Surface Treatment, Inverted Penetration Type. Class A

**2305.01 DESCRIPTION.** This work shall consist of the construction of a bituminous surface on a prepared base. When so provided in the contract, the base shall be primed as a part of the construction of the surface. The surface shall be constructed in accordance with the following requirements:

**2305.02 MATERIALS.** The materials used shall comply with the provisions of Part IV as specified below:

- A. **Aggregates.** Aggregates shall comply with the requirements of Section 4111. Unless otherwise specified in the contract,  $\frac{3}{4}$ -inch cover aggregate shall be used.
- B. **Bituminous Materials.** Bituminous materials used shall be of the type and grade specified and shall comply with the requirements of Section 4120 for that type and grade.

**2305.03 EQUIPMENT.** The equipment used shall be of types approved by the Engineer and shall be kept in satisfactory working condition.



A. **Aggregate Spreaders.** Aggregate spreaders are required for applying aggregate to the roadway surface. They shall have a mechanical feed of a length at least equal to the width to which aggregate is spread at a single passage of the spreader. They shall deposit the aggregate from the transporting vehicle directly on the fresh bitumen in a smooth, uniform layer, at the rate required, and in such a manner that no equipment will come in contact with the binder bitumen until the bitumen is covered with a layer of aggregate. The spreaders shall be so equipped that they may be filled and moved without discharging aggregate.

B. **Equipment for Distributing Bitumen.** All distributors and supply tanks shall be mounted on dependable motor trucks or trailers, equipped with pneumatic tires. Distributors shall be provided with burners, with heating coils and means to circulate the bituminous material in the distributor tank when the burners are in operation. The controls and the platform for the operator shall be mounted at the rear of the distributor.

Each unit from which bitumen is spread shall be equipped with an accurate thermometer, indicating the temperature of the bitumen in the distributor tank, a tachometer, operated by a wheel independent of the truck wheels, a calibrated measuring stick, a quick opening gate in the dome of the distributor tank, and quick cut-off valves at the nozzles, or means for reversing the direction of flow through the nozzles. Each supply tank used to deliver bitumen direct to a spray bar or to a distributor during spreading operations shall be equipped with accurate thermometer indicating the temperature of the bitumen in the tank.

The power for the pressure pump shall be supplied by a power unit entirely independent of the unit which provides motive power for the distributor. The distributor pump and its power unit shall have pumping capacity sufficient to supply the bitumen to spray bars of the maximum width used at a pressure sufficient to produce a fine, even spray, and shall be capable of distributing bitumen at rates varying from 0.05 gallons to 0.5 gallons per square yard.

The spray bars shall be equipped with means of lateral shifting, at least 9 inches each way from their center po-



sition, to insure contact of successive applications and shall be adjustable for widths of application required by the work. The spray bars shall be adjustable vertically to insure uniform distribution of bitumen.

For the distribution of emulsions, the spray bars shall be long enough to permit application to the full normal width of treated surface at one passage of the distributor.

The Contractor shall provide tables, prepared by the manufacturer, showing rates of distribution for tachometer readings, widths of spray bars, and pressures of bitumen, which will enable the Engineer to predict and control the spreading rate.

The tanks of all distributors and supply tanks shall be calibrated by the Engineer before being used. The Contractor shall furnish all equipment, materials, and assistance necessary for such calibration.

- C. **Brooms.** A power driven rotary broom is required for cleaning the surface of the base course before bitumen is applied and may be required for the redistribution of displaced aggregate during the construction of the bituminous surface. Such brooms shall be driven by an auxiliary motor or by a power take-off from the power plant of the unit propelling the sweeper. The sweeping unit shall be equipped with a suitable shield to prevent the loss of material beyond the limits of the area being treated.

A broom of one of the types specified below is required to smooth aggregate after placement and prior to rolling:

Brooms of the drag type shall be not less than 15 feet long, and shall have at least 4 transverse brushes at least 6 feet long. Each brush shall consist of not less than 5 longitudinal rows of spring steel bristles not less than  $\frac{3}{4}$  inch wide and projecting not less than 4 inches. The broom shall be so constructed and weighted as to distribute cover aggregate uniformly.

Brooms mounted beneath graders or tractors shall consist of not less than two of the brushes specified in the preceding paragraph. The brush unit shall be so mounted that its angle with the direction of travel and its vertical position can be adjusted and controlled.



- D. **Heating Equipment.** Equipment for heating bituminous material in tank cars shall have adequate capacity to heat the material by circulating steam through coils in the cars, or by circulating the bitumen through a separate heating unit. The heating equipment shall be provided with an accurate thermometer to indicate the temperature of the bituminous material in the unit in which heat is being applied. The use of equipment or methods which will injure or will introduce moisture into the bituminous material will not be permitted.
- E. **Roller.** A smooth faced steel roller and a pneumatic tired roller shall be used to embed cover aggregate into binder bitumen. Such rollers shall weigh not less than 200 pounds per inch width of roller. Pneumatic tired rollers shall be so constructed that not less than 75 per cent of the entire surface for the full width of the compacting unit is compacted at a single passage of the roller. Pneumatic tired rollers shall be operated at an inflation pressure not less than 25 pounds per square inch.
- F. **Weighing Equipment.** Scales for weighing loaded trucks at the roadside shall be of rugged construction and capable of being transported without loss of accuracy. They shall have capacity sufficient to weigh the maximum gross load used. They shall be accurate to 0.5 per cent of the total load and shall be sensitive to 10 pounds. They shall be designed for weighing loaded trucks. When aggregates are weighed by batches into trucks, the bins and batch scales used shall conform to the requirements stipulated for this equipment in Articles 2301.07 and 2301.16C.

#### 2305.04 CONSTRUCTION DETAILS.

- A. **Preparation of Base Course.** The Contractor shall clean all loose or foreign material from the area to be surfaced. Dust shall be removed by brooming with a power driven sweeper. Loose material removed from the road surface shall be bladed or swept over the shoulders, unless otherwise directed by the Engineer.
- B. **Heating Bituminous Material.** Bituminous material shall be heated to a temperature which will permit uniform spreading. Under ordinary conditions the Fahrenheit temperature to which the various material shall be heated shall be within the following limits:



Designation	Temperature	Designation	Temperature
SC-0	100-120	RC-0	80-90
SC-1	130-160	RC-1	100-120
SC-2	150-200	RC-2	120-150
SC-3	200-250	RC-3	150-200
SC-4	230-300	RC-4	220-250
SC-5	250-325	RC-5	250-300
SC-6	300-350		
MC-0	80-100	RT-2	90-125
MC-1	100-140	RT-3	120-140
MC-2	130-150	RT-4	130-150
MC-3	180-225	RT-7	130-150
MC-4	200-250	RT-8	170-200
MC-5	230-275	RT-9	200-225

Note: Some of the temperatures prescribed above may be above flash point of the material. Extreme caution must be used in handling such materials to reduce fire hazard.

Material which has been injured by overheating shall be rejected.

The Engineer may require higher temperatures than those shown above, if necessary to secure satisfactory distribution of bitumen on the road surface. The Engineer may require heating of emulsions to secure the uniform consistency desired.

### C. Spreading Bituminous Materials.

1. **General.** The distributor shall be operated at such speed and with such control setting as will deliver the desired amount of bituminous material per square yard. The quantity of bituminous material spread as priming coat or as binder for the surface mixture for any unit length of road surface being worked shall be between 95 and 105 per cent of the quantity specified by the Engineer.

The rate of applications shall be corrected for temperature to deliver the desired volume at 60° F. The curbs and handrails of bridges, guard rails and headwalls of culverts shall be protected by a suitable covering to prevent them from being soiled by bitumen and such covering shall remain in place until the bitumen has set and no splashing occurs under traffic.

2. **Primer.** When priming is a part of the contract, the type and grade of primer bitumen specified in the special provisions shall be applied at the specified



rate in accordance with the above general requirements and the following: The priming coat shall be allowed to thoroughly penetrate the base at least 24 hours after application before any traffic will be permitted upon it, or before the surface treatment may be applied. If at the end of twenty-four (24) hours after application there remain pools or spots of excess bitumen on the road surface the Engineer may require such pools or spots to be hand-broomed or blotted with aggregate to prevent the primer from being picked up.

If portions of the priming coat fail to adhere to the road surface because of dust or loose material or moisture, or if the surface becomes displaced or rutted by traffic the Engineer may require those portions to be thoroughly cleaned and reprimed at the contract price for primer bitumen applied. The primer coat shall be applied to the full width of surface to be treated before the binder coat shall be applied.

Bituminous material shall be applied as primer only when the road surface is dry and warm enough to obtain the proper penetration. This will usually require a minimum temperature of the road surface of 70°F.

3. **Binder.** When the primer has thoroughly set, the roadway surface to the width shown on the plans shall be swept clean of all loose aggregate or other material which might prevent adhesion and shall be given a coating of bituminous binder. Unless otherwise specified, this coating shall provide the following net amounts of binder corrected to 60°F. per square yard of surface for the number of applications specified:

Type of Bitumen	Number of Applications	Net Gal. Per Sq.	
		Yd. at 60° F. per Application	Total
Slow Curing (SC) ....	2	0.225	0.45
Medium Curing (MC) ..	2	0.3	0.6
Rapid Curing (RC) ..	2	0.3	0.6
Tars (R1) .....	2	0.3	0.6
Emulsions (EA) .....	3	0.3	0.9



On any section of road, each application of binder shall be completed to the full width of roadway to be treated before cover aggregate is spread. The second or third application shall not be placed until the cover for the preceding application has been spread, smoothed and rolled.

Bitumen shall be applied not more than one distributor load in advance of the application of cover aggregate. The Engineer may require this distance to be reduced to insure that the bitumen will be covered with aggregate promptly.

The laps of successive applications of binder shall not fall in the same vertical plane. The distance between centers of laps of successive applications shall not be less than 2 feet.

At all transverse joints uniform distribution of bitumen at the rate prescribed shall be secured by the use of acceptable squeegees after the passage of the distributor from which bitumen has been applied. Care shall be taken to see that a smooth riding surface is secured.

Binder bitumen shall be applied only when the road surface is free from moisture and uniform distribution can be secured, which will usually require a minimum atmospheric temperature of 50°F.

- 4. Storage of Excess Bitumen.** When the required quantity of any grade of bitumen is less than one minimum car, bids will be received on the basis of one minimum car. When the required quantity of any grade of bitumen is more than one maximum car and less than two minimum cars, bids will be received on the basis of two minimum cars. In all cases the Contractor shall furnish bitumen in cars of a capacity or a combination of capacities which will result in the minimum quantity of unused bitumen remaining after completion of the project. When two or more projects are bid in combination, the above rule will apply to the total bitumen requirements of the combined projects. Unused bitumen remaining at the completion of a project or combination of projects, provided shipments have been made in accordance with the above rule, shall be placed in containers furnished by the County at points where bituminous



materials are delivered in tank cars. No other bitumen will be stored for maintenance.

**D. Cover Aggregate.**

1. **Delivery.** Before being spread or placed in stock-piles, aggregate will be weighed on scales furnished by the Contractor. If materials from two or more sources are combined to produce the required gradation they shall be thoroughly mixed before being applied to the road surface.

At the time of spreading, the aggregate shall not contain more than 4.0 per cent of surface moisture, based on dry weight.

2. **Spreading.** The cover aggregate for each portion of the surface shall be spread as soon as the binder bitumen has been applied. The aggregate shall be spread by mechanical spreaders in a smooth, uniform layer at the rate required for the amount of binder applied. This operation shall be so conducted that the wheels of trucks or aggregate spreaders are kept off the binder coat until after it has been covered with aggregate. Uneven distribution of aggregate shall be corrected by hand spotting, raking or brooming immediately behind the mechanical spreader. The total quantity of cover aggregate spread will be approximately 60 pounds per square yard of surface, unless otherwise shown in the special provisions. This amount will be divided approximately equally between the number of applications specified in Paragraph 2305.04-C(3) for the bitumen being used. This quantity may be increased or decreased by not more than 20 per cent when directed in writing by the Engineer. If excessive bleeding occurs the Contractor shall place additional aggregate at such locations and in such quantities as the Engineer may direct. Such aggregate shall be placed at the contract unit price.
3. **Material for Future Use.** At points designated by the Engineer, the Contractor shall store aggregates for future use. The quantity to be stored shall be approximately 100 tons per mile of road under contract. The materials shall be stored in neat piles of regular cross section not less than 4 feet high. The Contractor shall blade off sod and prepare a clean,



nished by the Contractor as specified in the contract. Unless otherwise specified, the material will be spread by state forces and consolidated under traffic. These specifications shall apply to new construction or to the resurfacing of a previously surfaced road.

**2307.02 MATERIAL.** The material shall conform to the requirements of Section 4108 for the class and grade of material specified in the contract, or pit run material from locations designated in the contract documents.

**2307.03 CONTRACT SCHEDULE.** A contract may involve any of the following:

- A. Furnishing and delivering surfacing material complete on the road.
- B. Preparing and delivering on the road, material furnished by the County in deposits specified in the contract documents.
- C. Preparing material furnished by the County in deposits specified in the contract documents and hauling the material one mile, plus additional half-mile units of haul.

The preparation of material furnished by the County shall include the removal of the material from the deposit and such sorting, crushing, screening and washing as may be necessary to produce finished material which will comply with the specifications for the class and grade of material required by the contract documents. Delivering or hauling shall include loading, transporting and depositing the prepared material. All oversize particles 7 inches and less in diameter included in gravel furnished by the County shall be crushed to pass a  $\frac{3}{4}$ -inch sieve.

When surfacing material is furnished by the County in deposits, the County shall furnish the right-of-way necessary for suitable road from the deposit to a public highway. The Contractor shall assume responsibility for any construction or maintenance work that may be required on the road from the deposit to the public highway.

**2307.04 PREPARATION OF SUBGRADE.** The subgrade shall be shaped to a smooth surface having proper grade and cross section. The shaping of the subgrade will be done by the County unless otherwise specified in the contract.



**2307.05 STRIPPING AND WASTE.** The Contractor will be required to remove from materials furnished by the county all materials which may not be included in the surfacing material.

Stripping shall be construed to include the removal and disposition of material which may not be included in the prepared surfacing material and which occurs in the material deposit in continuous layers 6 inches or more in thickness overlying or included between layers of satisfactory surfacing material.

Waste shall be construed to mean the removal and disposal of material which occurs intermingled with satisfactory surfacing material and which is removed from the surfacing material in the process of preparation. In stripping deposits of material furnished by the County, care shall be taken to avoid unnecessary injury or disfigurement of the land. The material removed as stripping or waste shall be disposed of as directed by the Engineer.

**2307.06 HAULING AND PLACING.** Surfacing material shall be transported in vehicles so constructed and loaded that the amount of material in each load can be readily determined. Material shall be delivered on the road only when the subgrade can be maintained in proper condition. The Contractor shall place the material on the subgrade at the location and in the amounts designated by the Engineer. When so indicated in the contract documents, the material shall be placed in stockpiles at designated locations. Such stockpiles shall be regular in cross section and neat in appearance.

**2307.07 MIXING MATERIALS.** Under normal operating conditions the material delivered on the road will be a finished mixture conforming to the requirements for the class of material specified. With the approval of the Engineer, the specified gradation may be produced by delivering on the road two separate materials and combining them by mixing on the road surface in accordance with the following provisions:

- A. **Quality.** Materials from each separate source shall conform to the requirements of Section 4108 for the class of surfacing specified in the contract, except as to gradation of particles. In addition to the gradation requirements specified the final mixture shall be well graded from coarse to fine and the percentage passing the Number 30 sieve shall not be more than two-thirds of the percentage passing the Number 8 sieve. When crushed



sary to complete the contract in conformance with the plans and these specifications:

- A. **Furnishing and Delivering Materials on the Road.** The contract price per cubic yard or per ton, as specified in the contract, for furnishing and delivering surfacing materials on the road shall be full payment for furnishing, preparing, handling, transporting and depositing the material on the road in accordance with the contract and these specifications.
- B. **Preparing and Hauling Material Furnished by the County.** The contract price per cubic yard for preparing and hauling material furnished in deposits by the Commission shall be full payment for removing, sorting, crushing, screening, washing and transporting the material in accordance with the contract and these specifications. The number of additional cubic yard half-mile haul units computed as specified above shall be paid for at the contract unit price therefor.
- C. **Stripping.** Unless the contract provides a separate unit price for stripping, this item will not be paid for separately, but will be considered as included in the contract unit price for preparing and hauling the material. When the contract provides for payment for stripping the cubic yards of excavation and the number of station yards of overhaul computed as specified above will be paid for at the contract unit prices for these items.
- D. **Waste.** Payment will not be made for waste as a separate item but shall be considered as included in the contract price for preparing and hauling the material.



## DIVISION 24. STRUCTURES

This work shall consist of construction of various types of structures of wood, steel or concrete for bridges, viaducts, grade separations, retaining walls, culverts, or other drainage structures, in accordance with the detailed plans and requirements for the respective types in the sections listed below. The work of clearing and grubbing, channel change, and revetment will be handled, measured, and paid for in accordance with provisions of Section 2101, 2104 and 2507, respectively.

- 2401 Removal of Existing Structures.
- 2402 Excavation for Structures.
- 2403 Concrete Masonry.
- 2404 Reinforcement.
- 2405 Foundations and Substructures.
- 2406 Concrete Structures.
- 2407 Steel Structures.
- 2408 Timber Structures.
- 2409 Plank Floors.
- 2410 Laminated Wood Floors.
- 2411 Concrete Floors.
- 2412 Asphalt Plank Wearing Surface.
- 2413 Bituminous Mat Wearing Surface.
- 2414 Railings.
- 2415 Concrete Box Arch and Circular Culverts.
- 2416 Rigid Pipe Culverts.
- 2417 Corrugated Metal Pipe Culverts.
- 2418 Installation of Pipe Culverts by Jacking.
- 2419 Laminated Wood Culverts.
- 2420 Sectional Plate Pipe and Arches.

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### Section 2401. Removal of Existing Structures

2401.01 DESCRIPTION. This item shall consist of the removal and disposal of all portions of existing structure, except such portions as may be required or permitted to be left in place by these specifications, or as specified on the plans or in the Special Provisions. All materials removed shall remain the property of the County. Unless otherwise shown on



the plans or in the special provisions, it will be assumed the structure will be re-used.

Any temporary structure for the maintenance of traffic, over or around the site of the work, shall be included in this same category.

#### **2401.02 REMOVAL OF STEEL SUPERSTRUCTURES.**

Steel superstructures which may be re-erected in new locations shall be dismantled and removed in such manner as will avoid damage to any of the members.

All members of trusses shall be clearly and neatly match marked with white paint before dismantling. All pins, nuts, loose plates, etc., shall be similarly marked to indicate their proper location in the structure. Pins, pin holes and machined surfaces shall be cleaned and coated with white lead and tallow. All loose small parts shall be wired to adjacent members or packed in boxes.

Steel superstructures which are unfit for re-erection will be designated on the plans or in the Special Provisions. Such structures shall be removed by methods which will prevent their re-erection.

#### **2401.03 REMOVAL OF SUBSTRUCTURES.**

Unless otherwise required by the Special Provisions or ordered by the Engineer, all portions of substructures above the bed of the stream or ground surface as it existed before work on the current contract was started, and all portions below the bed of stream or ground surface which interfere in any way with the new construction shall be removed. Blasting or other operations which might endanger the new work shall be completed prior to constructing any part of the new structure.

#### **2401.04 DISPOSAL OF STEEL.**

All structural steel members shall be stored in neat piles in locations specified on the plans or within the right of way in the vicinity of the work at points designated by the Engineer.

Members of structures which are to be re-erected shall be stored on skids above the surface of the ground.

#### **2401.05 DISPOSAL OF CONCRETE AND MASONRY.**

Concrete and masonry removed from old structures will usually be placed in backfills or approach embankments. All material shall be disposed of in a manner which will avoid damage to adjacent property and the creation of unsightly conditions.

#### **2401.06 OTHER STRUCTURES.**

Pipe culverts and other small structures which, in the opinion of the Engineer, are of



usable quality shall be removed by methods which will preserve their usefulness. These items will be stored within the right-of-way in vicinity of the work at points designated by the Engineer.

**2401.07 BACKFILLING.** When part or all of an old structure to be removed lies outside the limits of the new construction, any excavation for the purpose of removal of the old structure below the finished grade line shall be backfilled with suitable earth to the original ground level or to the finished grade line, whichever is the lower, in accordance with provisions of Article 2402.09.

**2401.08 BASIS OF PAYMENT.** When the contract includes a price for removal of old structures the Contractor will be paid the contract price therefor. When no price has been provided in the contract, this item, including backfilling made necessary by this operation, will be considered as extra work and shall be paid for as provided in Paragraph 1109.04-B.

The contract price for the removal of an existing structure shall be full payment for furnishing all material, equipment and labor and the performance of all work necessary to the removal of the old structures and the disposal thereof, and for any backfilling made necessary by these operations, in accordance with the plans and these specifications.

## Section 2402. Excavation for Structures

**2402.01 DESCRIPTION.** Excavation for structures shall consist of the removal of all material necessary for the construction of the work included in the contract, in conformity with the plans and these specifications. It shall include the furnishing, placing and removal of all cofferdams, shoring and bracing and the disposal of all surplus material as hereinafter provided. When the contract does not provide a separate price for removal of old structures or parts of structures such removal shall be considered as extra work and shall be paid for as provided in Paragraph 1109.04-B.

Sounding and test boring data shown on plans were accumulated for design and estimating purposes. Their appearance on the plans does not constitute a guarantee that conditions other than those indicated will not be encountered in the excavation or in the material penetrated by piling.

In the case of a single contract involving both channel



excavation and excavation for structures, none of the excavation included within the volume limits of channel excavations as shown on the plans, shall be included in the measurement of excavation for structures.

**2402.02 CLEARING AND GRUBBING.** All trees, stumps and brush existing on the site of the work, the removal of which is necessary to the completion of the work, shall be removed. The removal of such trees, stumps and brush shall be considered as a part of the contract for the structure. As a part of the contract for a structure, the Engineer may order the removal of trees and stumps which are near to but not on the site of the work if the presence of such trees and stumps will interfere with the completion of adjacent parts of the improvement of which the structure is a part and if their later removal by usual methods would endanger the structure. No blasting shall be done within 50 feet of any completed part of a structure.

Clearing and grubbing will be done in accordance with the provisions of Section 2101.

**2402.03 ELEVATIONS AND DIMENSIONS OF FOOTINGS.** Under normal construction conditions, footings will be constructed to the elevations shown on the detailed plans. The Engineer may order, in writing, such changes in dimensions or elevations of bottoms of footings as may be necessary to secure a satisfactory foundation.

**2402.04 TREATMENT OF FOUNDATION MATERIALS.** If rock foundation is secured the excavation shall be done in such a manner as to allow the rock to be exposed and prepared for receiving the concrete or masonry. All loose and disintegrated rock or thin strata shall be stripped to a clean bed acceptable to the Engineer.

All seams or crevices shall be cleaned out and filled with concrete or mortar.

Whenever the footing is to rest on any excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the final finishing of the surface shall not be done until just before the footing is to be placed.

**2402.05 CONSTRUCTION OF COFFERDAMS.** Cofferdams shall be constructed to comply with the requirements of Article 2405.02.



**2402.06 REMOVAL OF COFFERDAMS.** Unless otherwise shown on the plans, cofferdams and all sheeting and bracing shall be removed by the Contractor after the completion of the substructure.

**2402.07 INSPECTION OF EXCAVATION.** After each excavation is completed the Contractor shall notify the Engineer, who shall make an inspection of the depth of excavation and character of the foundation material. No concrete shall be placed until after the Engineer has approved the depth of excavation and character of foundation material. The Commission shall be responsible for delays caused by failure to make inspection within 24 hours after notice has been given the Engineer or his representative by the Contractor or his authorized agent.

**2402.08 DISPOSAL OF EXCAVATED MATERIAL.** All materials excavated by the Contractor for bridge or culvert work shall be disposed of so as to leave the site in a neat condition. Material suitable for backfilling shall be used for that purpose to the extent required to completely backfill the structure to the original ground level or the elevation shown on the plans.

Material suitable for approach fills and not required for backfilling shall be placed in the approach fills. Material not suitable for backfilling or approach fills shall be wasted as directed by the Engineer.

Material used for backfilling abutments or culverts or in approach fills shall be earth or other approved material, free from spongy or vegetable substances and shall contain no lumps or frozen materials.

**2402.09 BACKFILLING.** Completed structures shall be backfilled in accordance with the following requirements.

Except as provided in Article 2403.24, at least 14 days shall elapse after the concrete has been placed before backfilling is placed against concrete culverts, abutments, piers, arches or wing walls or against timber abutments or wing walls which depend upon cast-in-place concrete deadmen for anchorage.

No backfilling shall be placed against timber abutments or wing walls until all required anchor rods are in place and functioning. Neither shall any backfill be placed against any timber abutment or wing wall which is designed to gain support from a superstructure until the superstructure is in place and permanently fastened to the substructure.



Backfill material may be placed in water only when the removal of the water from the area to be backfilled is impractical, as around piers or abutments located within the waterway or in other deep excavations where the removal of cofferdams is required before backfilling and such removal prevents unwatering. Backfill material placed in water need not be artificially consolidated.

Backfill material placed above water line shall be placed in layers not more than 6 inches in loose thickness. Each layer shall be thoroughly compacted before material for the next layer is placed. Except as noted below, all compaction shall be accomplished by rolling or tamping with an approved roller or mechanical tamper. Pneumatic tampers shall be supplied with air at a pressure not less than 100 pounds per square inch at the compressor.

Where backfill is required on both sides of a concrete wall, abutment or other monolithic structure, filling operations shall proceed simultaneously on both sides of the structure so that the two fills are kept at approximately the same elevation at all times. For the purposes of this paragraph, concrete box, arch and circular culverts and rigid frame bridges, except wing walls, shall be considered to be monolithic structures.

Backfills around pipe culverts and laminated wood culverts shall be placed in conformance with the requirements of Sections 2416, 2417, 2418, 2419 and 2420.

Where backfill is to be placed on one side only of retaining walls, wing walls, high head walls on culverts, or the abutments of bridges so designed that the superstructure does not aid in withstanding earth pressures behind the abutments, no rolling or mechanical tamping shall be done within 3 feet of the supporting surface, but hand tamping will be required in this area.

Excavations made for substructures of arches shall be backfilled in accordance with the foregoing requirements.

Backfilling above the skewbacks (spandrel filled arches) shall be placed to conform to the following requirements:

Eccentric loading of the arch shall be avoided by carrying on backfilling operations simultaneously on both halves of the span. In the case of a multiple arch structure all intermediate fills between arches, as well as the approach fills, shall be constructed simultaneously.

The filling material shall be deposited in layers not more than 6 inches in depth before compaction and each shall



be thoroughly compacted by rolling or mechanical tamping before the next layer is placed, except that no rolling or mechanical tamping shall be done within 3 feet of any wing wall, parapet wall or spandrel wall. Hand tamping will be required in this area.

The layers of backfill material shall be so deposited as to slope upward toward the crown of the arch and dip downward over the haunches.

The rate at which material is placed in the various parts of the area to be backfilled shall be so controlled that the ratio of depth of fill placed to depth of fill required will be kept approximately equal over the entire span.

**2402.10 EXTRA EXCAVATION FOR FILLS.** When the plans show an item for extra excavation for fill, unless the construction of this fill is specifically exempted from the contract, the Contractor shall construct the fills to the height shown on the plans and to the full width of the roadway embankment. Material for making such fills shall be secured from within the waterway of the structure when the quality of such material is satisfactory or from near the ends of culverts in such a way as to improve inlet and outlet conditions. If other material is required it shall be secured within the right of way as directed by the Engineer.

All borrow pits opened for such extra excavation shall be finished in a neat and workmanlike manner with adequate provision for drainage.

**2402.11 CLASSIFICATION OF EXCAVATION.** All excavation for structures will be classified as Class 20, Class 21, Class 22, Class 23 or Class 24 as defined in this Article.

Class 20 excavation shall include all excavation for bridges above the excavation classification line shown on the plans and not classified as Class 22 excavation.

Class 21 excavation shall include all excavation for bridges below the excavation classification line shown on the plans and not classified as Class 22 excavation.

Class 22 excavation shall include the measured volume of granite, trap, quartzite, chert, limestone, sandstone, hard shale or slate in natural ledges or displaced masses. It shall also include the estimated or measured volume of rock fragments or boulders having a volume of one cubic foot or more.

Class 23 excavation shall include all excavation included under the definitions of Classes 20, 21 and 22 and any other



material encountered regardless of its nature, except for removal of old structures or parts of structures. All excavation for culverts except the additional excavation necessary to make the required backfill, shall be classified as Class 23 excavation.

Class 24 excavation shall include only the additional excavation necessary to provide material for backfills, approach fills, berms, or a roadway over the structure when the material resulting from other classes of excavation for the structure is of insufficient quantity or of unsatisfactory quality for these purposes.

**2402.12 METHOD OF MEASUREMENT.** All Class 20, Class 21, Class 23 and Class 24 excavation shall be measured in cubic yards in its original position by the cross section method.

Class 22 excavation shall be measured as provided above wherever practical. Boulders may be measured after excavation.

The yardage of excavation paid for will be that actually removed, except as provided in this Article for culverts and except that unless required by the plans or ordered by the Engineer no payment will be made for material removed outside areas bounded by vertical planes parallel to the boundaries of the structure or part of structure and located as follows: For monolithic culverts, 12 inches outside the footings; for concrete structures, pipe culverts, or parts of structures without footings, 18 inches outside the horizontal projection of the structure or part of structure; for concrete structures with footings, 18 inches outside the footings; for timber abutments and wing walls, 24 inches behind the backing plank; for anchor rods, 12 inches on each side the rod; for deadmen, the face of the deadman on one side and 24 inches outside the deadman on the other face. The Contractor shall notify the Engineer 48 hours in advance of beginning excavation so that the necessary measurements of the existing ground may be made. Payment will not be made for any material removed before these measurements are made. In the case of two or more footings supporting a pier or similar structure which is continuous between footings at any elevation below the excavation classification line, the planes described above shall be located as if the footings were continuous and of the width of the footings to be built.

It is understood that the estimated quantities of excavation shown on the plans are approximate only, but are computed from data available for the preparation of plans and on the



basis of the volumes required to be removed inside the planes surrounding the structure as described above.

When a culvert is built without change in location, dimension or elevation, the quantities of Class 23 and Class 24 excavation as shown on the detailed plans shall be the quantity for which payment is made.

When the location, width or length of a culvert has been changed from that specified on the plans, the quantities of excavation shall be measured by the Engineer as indicated above.

When the elevation of the flow line of a culvert has been changed from that specified on the plans, the plan quantity of Class 23 excavation for the structure shall be increased when the flow line has been lowered and shall be decreased when the flow line has been raised. Such change in quantity shall be that obtained by multiplying the area bounded by the vertical planes defined above, by the change in the elevation of the flow line. The plan quantity of Class 24 excavation shall be increased or decreased by the amount necessary to furnish the increased or decreased quantity of fill.

**2402.13 BASIS OF PAYMENT.** The quantities of Class 20, Class 22, Class 23 and Class 24 excavation measured as provided above will be paid for at the contract prices per cubic yard for such excavation except as provided in Paragraphs A, B, C and D of this Article.

**A. Extra Depth Excavation for Structures Other Than Culverts.** Upon written order of the Engineer the Contractor shall excavate for footings to depths below those shown on the plans. When the extra depth of excavation does not exceed 6 feet, payment will be made for each extra foot of depth at the following percentages of the contract unit price for the excavation at the footing elevation shown on the plans.

	Class 20 Excavation	Class 21 or 23 Excavation
First Foot .....	110%	120%
Second Foot .....	120%	140%
Third Foot .....	130%	160%
Fourth Foot .....	140%	180%
Fifth Foot .....	150%	200%
Sixth Foot .....	160%	220%



When the extra depth of excavation exceeds 6 feet, all excavation below the elevation of the bottom of the footing as shown on the plans shall be paid for as extra work as provided in Paragraph 1109.04-B.

When the extra depth excavation necessitates the removal and reconstruction of a cofferdam which complied fully with the requirements of Article 2405.02 the cost of the removal of the old cofferdam and the construction of the new one shall be paid for as extra work as provided in Paragraph 1109.04-B.

- B. **Excavation for Changes in Horizontal Dimensions of Footings.** On written order of the Engineer, the Contractor shall construct footings having horizontal dimensions other than those shown on the plans. When such a change necessitates the removal and reconstruction of a cofferdam which complied fully with the requirements of Article 2405.02, the cost of the removal of the old cofferdam and the construction of the new one shall be paid for as extra work as provided in Paragraph 1109.04-B. Payment for excavation will be made at the same unit prices as if there had been no change in dimensions of the footings.
- C. **Overhaul.** Material from classes of excavation other than Class 24 will ordinarily be deposited within 50 feet from the excavation as directed by the Engineer. Overhaul will be paid on excavated material other than Class 24 in accordance with the provisions of Section 2107 except that the free haul limit shall be 50 feet and the payment for overhaul shall be 5 cents per station yard. Overhaul will be paid on material of Class 24 excavation in accordance with the provisions of Section 2107 except that the free haul limit shall be 500 feet.
- (D) **Unexpected Rock Excavation.** When the contract for a structure, other than a culvert, contains no unit price for Class 22 excavation, any material required to be excavated which conforms to the definition of Class 22 excavation shall be paid for at  $3\frac{1}{2}$  times the contract unit price for the class of excavation in which it is encountered subject to the provision for over-depth as provided in Paragraph A of this Article. The provisions of this paragraph shall not apply to excavation for culverts.



The price paid for excavation shall in all cases be full payment for removing, transporting and disposing of all excavated material; for pumping and for placing and removing all cofferdams, shoring and bracing.

### Section 2403. Concrete Masonry

**2403.01 DESCRIPTION.** Concrete shall be composed of Portland cement, fine and coarse aggregate and water, mixed in the proportions specified herein for the various classes. The class of concrete shall be Class A unless otherwise shown on the plans.

**2403.02 MATERIALS.** All materials used shall comply with the requirements of Part IV.

The use of high early strength Portland cement will not be required unless so stipulated in the Special Provisions. Unless otherwise specified, high early strength portland cement will be used in the same proportions as those specified above for normal Portland cement. Air entraining cement shall not be used unless required by the Special Provisions and only as provided in such Special Provisions.

**2403.03 PROPORTIONS FOR CONCRETE MASONRY.** Materials for concrete masonry may be mixed in any one of the following proportions for the class of concrete specified. The various proportions for each class of concrete may be used at the Contractor's option, provided the gradation of the coarse aggregate conforms to the sieve analysis required for that proportion.

Class of Concrete	Mix No.	Proportion by Dry Weight (lb. Cement to lb. Sand to lb. Coarse Aggregate)	Percent Sand in Total Aggregate by Weight	Approx bbl. Cement per Cubic Yard of Fresh Concrete
A	2	1-2.09-3.13	40	1.60
	3	1-2.23-2.72	45	1.66
	4	1-2.35-2.35	50	1.72
B	2	1-2.57-3.85	40	1.36
	4	1-2.96-2.96	50	1.44
C	-	1-2.5	100	---
	4	1-2.0-2.0	50	---
X	2	1-1.93-2.89	40	1.75
	3	1-2.05-2.51	45	1.82
	4	1-2.16-2.16	50	1.89

**A. Pit-Run Aggregate.** When approved by the Engineer, pit-run or unscreened aggregate may be used in combination with screened gravel or crushed stone to produce the proportions specified above, or it may be used in



**2403.06 MEASURING MATERIALS.**

A. **Cement.** Unopened cloth or paper bags of cement packed by the manufacturer will be accepted as weighing 94 pounds. Cement shipped in bulk shall be weighed for each batch, on scales which shall be within one pound of correct at all loads.

B. **Water.** The water measuring equipment shall be capable of accurate measurement to one quart and shall be so arranged that the accuracy of measurement will not be affected by variations in pressure of the water supply line.

Unless the water is measured by weight, the Contractor shall provide a container in which the entire quantity of water required for one batch of concrete may be weighed.

C. **Aggregates.** Aggregates shall be measured by weight. The weighing equipment used shall be approved by the Engineer and shall meet the following requirements:

1. The scales shall be accurate within 2 pounds at all loads.
2. At least that part of the load which is a fraction of 100 pounds shall be indicated on a graduated beam or springless graduated dial. Minimum graduation shall be 2 pounds for graduated beams or dials.
3. Convenient means shall be provided for removing an overload from the weighing containers.
4. The scales shall be of simple, rugged design, manufactured by an established manufacturer of weighing equipment and recommended by the maker for the kind of service for which they are to be used.
5. Beam scales which are used for weighing more than one aggregate shall have an independent beam for each material to be weighed.
6. Two standard 50-pound weights shall be available at all times for checking scales. These weights shall be kept clean and not used for other purposes than checking the accuracy of the scales.
7. All wheelbarrows or buggies used for weighing aggregate shall be plainly marked "Sand" or "Coarse Aggregate," according to the material which they will be used to convey. They shall also be plainly



numbered for identification and shall be provided with permanent means of adjusting the weight to a uniform tare.

**2403.07 MIXING.** Concrete shall be thoroughly mixed in an approved machine mixer of the batch type. The minimum capacity of the mixer shall be a one-bag batch. The capacity of mixing equipment for placing concrete bridge floors shall not be less than that of a mixer having a rated capacity of 10 cubic feet.

The concrete shall be mixed continuously for one minute after all the materials have been assembled in the drum. The minimum mixing time shall be indicated by an accurate timing device which shall be automatically started when the mixer is fully charged and shall lock the discharge chute until the expiration of the required time. The expiration of required mixing time shall be indicated by a clearly audible signal. During the time of mixing, the drum shall revolve at the speed for which the machine is designed, but not less than 12 or more than 20 revolutions per minute. The mixing drum of mixers of the tilting drum type shall be operated at an angle no steeper than that recommended by the manufacturer of the mixer. The total volume of the batch in cubic feet shall not be greater than the size designating number of the mixer. The size designating number shall conform to the Concrete Mixer Standards of the Mixer Manufacturers Bureau of the Associated General Contractors of America, Inc., in effect at the time the mixer was manufactured.

Mixers in which the drums are not clean or the effective height of the mixing blades or discharge buckets is reduced by 10 per cent or more of their original height shall not be used. Mixers shall be maintained in good working condition. Each batch of concrete shall be completely discharged from the mixer before the materials for the next batch are introduced. Upon cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned and flushed with water.

**2403.08 READY-MIXED CONCRETE.** Ready-mixed concrete may be used in lieu of concrete mixed at the site of the work as provided in the preceding Articles, except that such concrete may not be transported more than one-half mile unless the vehicle in which it is transported provides mechanical agitation of the concrete while in transit. The provisions of



Article 2301.18 shall apply to ready-mixed concrete furnished for structures.

**2403.09 RETEMPERING.** Retempering of concrete or mortar which has partially hardened, by re-mixing with or without additional materials shall not be permitted.

**2403.10 PLACING CONCRETE.** The concrete mixed at the site of the work shall be placed immediately after mixing. Ready-mixed concrete shall be placed immediately after delivery. Concrete shall be placed in a manner which will avoid segregation or separation of the ingredients. In placing concrete all the following precautions shall be observed:

1. In handling concrete from the mixer to the place of deposit care shall be taken to avoid segregation of the ingredients.
2. When concrete is deposited through a chute the slope of the chute shall be such as will allow the concrete to flow slowly without segregation. The delivery point of the chute shall be as close as possible to the point of deposit.
3. The free fall of concrete from the end of the spout or chute or from a transporting vehicle shall not exceed 5 feet for the side walls of culverts and shall not exceed 3 feet for other types of construction.
4. When the distance through which concrete is dropped vertically exceeds the maximum specified in the preceding paragraph, a tremie or flexible metal spout shall be used. Flexible metal spouts shall be composed of conical sections not more than 3 feet long, with the diameter of the outlet end and the taper of the various sections such that the concrete will fill the outlet and be retarded in its flow. Such flexible metal spouts shall be free from projections on their inside surfaces.
5. Chutes shall be of metal or be lined with metal. Chutes and spouts shall be kept clean. They shall be thoroughly flushed with water before and after each run. The water used for flushing shall be discharged outside the forms.
6. Concrete shall not be deposited in large quantities at a single point and then caused to flow along inside the forms.
7. In depositing concrete, care shall be taken to entirely fill the form without bulging the form or disturbing its alignment.



8. Special care shall be taken in filling forms to work the coarser aggregate away from the faces of forms and to force the concrete under and around reinforcement. The concrete shall be worked with a spade, pointed steel rod or other satisfactory implement in such a manner as to bring a thick layer of mortar in contact with the forms and reinforcement and to prevent the formation of pockets of coarse aggregate.
9. No concrete shall be placed in water flowing under head within the area of a footing. Such flowing water shall be controlled in pipes or trenches outside the forms. In extreme cases a seal coat may be ordered to overcome this difficulty.
10. Concrete placed when the air temperature is at or below 40°F. shall be protected in accordance with Article 2403.12.

**2403.11 VIBRATED CONCRETE.** All concrete in bridge floors shall be placed by vibration or shall be finished with a vibrating screed and when specified in the Special Provisions, concrete for other bridge work shall be placed by vibration in accordance with the following provisions. For all work except thin, flat slabs, the vibrating units shall be of the internal rotating type. For thin, flat slabs, unbalanced vibrators firmly attached to the bottom forms or vibrating screeds on the surface may be used. The units may be driven by electricity, compressed air or by direct mechanical connection to the power unit. All vibrators shall be operated at speed not less than 3,500 vibrations per minute. Duplicate vibration equipment shall be provided to avoid delays due to breakdown.

The internal vibrators shall be manipulated through all available space in the mass of the concrete, with particular attention to corners and faces of concrete against forms and joints. Care shall be used to prevent the vibrator from penetrating any portion of the previously set concrete.

The vibration shall be applied to each batch of concrete as it is deposited in the forms. It shall settle and thoroughly consolidate the concrete into close contact with the forms, the reinforcement and previously placed concrete. When necessary, the vibration shall be supplemented by spading along the forms. The operations of depositing and compacting shall be so conducted that the resultant concrete, upon the removal of the forms, shall be smooth and dense, free from all honeycomb or pockets of segregated aggregate.



The forms shall be designed to withstand the effects of vibration without appreciable distortion from the desired shape or position. Vibration will temporarily increase pressure on the forms with consequent tendency to increase leakage. The number of vibrating units shall be sufficient to handle all batches and compact them promptly in place. The concrete shall be deposited as nearly as possible in its final location and shall not be caused to flow laterally in the form any considerable distance.

**2403.12 PROTECTION AND CURING OF CONCRETE.** Concrete which has been placed shall be protected from any vibration, jarring movement or external stress between the time it ceases to be plastic and the time it may be stressed in accordance with the provisions of Article 2403.24.

Runways for transporting materials over concrete floors less than 7 days old shall be supported directly over structural members or over piers or abutments so that the concrete in the floor is subjected to compressive stress only. Unless the concrete is protected as specified in Article 2403.13 the exposed surfaces, including surfaces from which forms have been removed, shall be kept wet and shall be covered, except during surface finishing operations, by means of burlap, paper, straw, sand or other satisfactory covering for a period of 4 days after the concrete has been placed. The burlap and paper used shall conform to the requirements of Section 4146 and 4145, respectively, except as to size of sheets.

**2403.13 PLACING AND PROTECTION IN COLD WEATHER.** No concrete shall be placed without the specific permission of the Engineer when the air temperature is at or below 40°F.

In no case shall any frozen material be used in the concrete. Concrete shall not be deposited against frozen forms, earth or rock or against other concrete having a temperature below 40°F.

In addition to adequate provision for protecting the concrete against chilling or freezing, the Contractor shall heat the water and aggregates so that when deposited in the forms the concrete will have a temperature not less than 60°F. nor more than 100°F. Aggregates shall be so heated and handled as to avoid injury to the aggregate by overheating and to insure uniform moisture content of aggregates entering the mixer. Aggregates may be heated by steam pipes or coils



through aggregate piles. Aggregates shall not be heated by direct dry heat unless they are mechanically agitated during the heating process.

Before concrete is placed at atmospheric temperatures below 40°F. the Contractor shall have provided protection and heating facilities adequate to maintain the temperatures set forth below:

The concrete and the air surrounding it shall be maintained at a temperature between 50° F. and 100° F. for the first 72 hours after the concrete has been placed, and at a temperature between 40° F. and 100° F. for the next 48-hour period. The temperature of the air surrounding the concrete shall then be gradually reduced to the outside air temperature at a rate not faster than 5° in any one hour and a total of not more than 20° F. in 24 hours.

In the case of piers and abutments more than 12 feet high, diaphragms shall be provided dividing the housing into sections each not more than 12 feet in height in order to control the vertical distribution of heat. During the curing process the concrete shall be protected from local overheating and from drying.

In the case of concrete, all of which is at least 1 foot below ground water level, the concrete may be flooded to a minimum depth of 1 foot in lieu of other methods of protection and curing, with the provision that concrete cured in this way may not be subjected to freezing temperatures within 10 days after it is placed.

If in the opinion of the Engineer the methods adopted for protection of concrete, placed above ground level, prove inadequate to maintain the schedule of temperatures of concrete and air surrounding it as set forth above, the Engineer may require such additional protection and heating as will insure the specified temperature, and for the period from December 15 to March 1 he may require concrete placed above ground level to be housed during the protection period, with two layers of canvas with not less than 3 inches of air space between.

At the Contractor's option, calcium chloride or high early strength Portland cement may be used. When calcium chloride is used it shall be added to the mixture as provided in Paragraph 2301.24-B at the rate of 2 pounds per bag of cement and the time of protection to keep the concrete above 50° F. may be reduced to 96 hours. When high early strength Portland cement is used the temperature of the concrete during the



first 72-hour period after placing shall not be less than 60° F. and the protection may then be removed as provided above.

#### 2403.14 PLACING LARGE VOLUMES OF CONCRETE.

Each monolithic section shall, whenever practical, be placed in one continuous operation. Whenever the volume is too great to be placed in one continuous operation, the work shall be subdivided as shown on the plans or as directed by the Engineer.

**2403.15 BONDING CONSTRUCTION JOINTS.** When the placing of concrete in any section of a structure must be interrupted the construction joint shall be located as specified in Article 2403.25. The surface of the concrete in horizontal joints, except in the area near the form, shall be left rough to increase the bond with the concrete that is to be placed later. To avoid visible joints as far as possible upon exposed surfaces, the top surface of the concrete adjacent to the forms shall be finished by being smoothed with a plasterer's trowel. Keyways shall be introduced by imbedding wood strips not less than 1½ x 3 inches in the surface of the concrete. Tapered sections which would otherwise result in a "feather edge" shall be so formed by an insert that the succeeding layer of concrete will end in a section not less than 6 inches thick. In addition to the key notches, in the concrete that is not reinforced, steel dowels not smaller than ¾ inch shall be set around the edge of the section at intervals not greater than 2 feet. The dowels shall project at least 1 foot on each side of the joint.

**2403.16 BONDING NEW AND OLD WORK.** When new concrete is to be placed in contact with old concrete or with concrete that has hardened, the surface of the existing concrete shall be thoroughly cleaned of all laitance, loose particles of concrete, dirt or other foreign materials, then roughened and thoroughly drenched with water until saturated. Care shall be taken to tighten the forms against the old concrete and to thoroughly compact the fresh concrete to insure good bond.

Dynamite shall not be used for removing a part of a structure to which an addition is to be made, except in the case of massive sections and only with the written permission of the Engineer. When dynamite has been so used the concrete for at least 6 inches beyond the point of visible damage shall



be removed by methods which will not injure the concrete which is to remain.

#### 2403.17 JOINTS BETWEEN CONCRETE AND STEEL.

All joints between concrete and structural steel members in either vertical or horizontal surfaces which are exposed to weather shall be provided with a recess not less than  $\frac{1}{2}$  inch by  $\frac{1}{2}$  inch for the purpose of caulking the joint as provided in Article 2508.06.

**2403.18 DEPOSITING CONCRETE UNDER WATER.** Concrete shall not be deposited under water except for the placement of seal coats.

When possible, seal coats shall be placed in one continuous operation. Concrete shall be placed to approximately the required depth progressing from one end over the entire area in such a manner that the volume of concrete will be gradually expanded without dropping the concrete through water and with the minimum amount of agitation. The surface of the seal coat shall be approximately level. Sumps or depressions for pumping out the water shall be placed outside the area of the footing.

The concrete shall be placed with a tremie or bottom dump bucket, meeting the approval of the Engineer.

A. **Tremie.** A tremie shall consist of a metal tube 8 to 12 inches in diameter, constructed in sections, with flange couplings, with gaskets and tight bottom valve, and so placed as to permit the initial and all subsequent charging to take place without the concrete being dropped through the water. In operating the tremie it shall be kept filled at all times and the discharge end shall be raised only an amount sufficient to permit the concrete to be discharged. Provision shall be made in supporting the tremie so that it may be readily lowered when necessary to "choke off" or retard the flow.

B. **Dump Bucket.** A dump bucket may be used if so designed that it may be opened when it rests upon the surface of the concrete that is to receive the charge. In lowering and raising the bucket care shall be taken to prevent any unnecessary movement of the water in the cofferdam.

**2403.19 LAITANCE.** All laitance or softened concrete shall be removed from the surface of seal coats before the



footing is placed. Care shall be used in placing of other concrete to prevent the formation of laitance on the surface of the concrete. All laitance shall be entirely removed by means of shovels, stiff wire brooms or other suitable methods before the succeeding layer of concrete is placed.

**2403.20 ADMIXTURES.** Approved admixtures may be used for the purpose of improving workability, upon permission of the Engineer. When so permitted, they shall be used in accordance with instructions issued by the Engineer.

**2403.21 FALSEWORK.** Falsework for supporting reinforced concrete superstructures and for supporting reinforced beams and cantilevers of substructures shall be built on foundations of sufficient strength to carry the load without appreciable deformation. Ample falsework piling shall be driven to support all falsework which cannot be founded on rock, shale, thick deposits of compact gravel or the heavier clays in their natural beds. On these materials mudsills or other spread footings may be used and shall be of a size to be determined by the load to be supported and the bearing value of the soil in question. Bearing values of all piles used to support falsework shall be determined as provided in Article 2501.13 and shall be at least equal to the loads imposed upon them during construction. The adequacy of mudsills as to size and soil bearing, the number and spacing of piles and the amount of bracing in the falsework framing shall be subject to checking and approval by the Engineer. Falsework shall be designed to carry the full loads coming upon it, without appreciable deformation. For calculating the strength of falsework and centering, the following values shall be used:

- A. Weight of "green" concrete—150 lbs. per cu. ft.
- B. Safe bearing value of firm sand, gravel, very firm clay and other similar confined soils in thick beds—2 tons per sq. ft.

Falsework for slab and girder bridges shall be set with an allowance for slight settlements, deformation of members, and closing of joints. In all cases, roadway surfaces, curbs, copings and railings shall be built to accurate grade and alignment. Girders or slabs, the lower surface of which show over one inch sag, may be rejected.

The Contractor's plans for falsework and centering on all concrete slab, girder and arch bridges, when requested by the



Engineer, shall be submitted in triplicate to the Engineer for checking and approval before being placed.

Falsework shall remain in place until the forms supported by it may be removed in accordance with the provisions of Article 2403.23.

In the case of a structure spanning natural streams or overflow channels of natural streams all falsework and falsework piling shall be removed to the ground level elevation contemplated for the improvement or the normal water level of the stream. In the case of structure spanning a drainage channel constructed under the drainage laws of Iowa, all falsework and falsework piling shall be completely removed.

**2403.22 FORMS.** Material used for forms shall be metal, surfaced lumber, plywood, masonite or hard pressed composition board backed by suitable studding, walers, etc. It shall be free from knot holes, cracks, splits, warps or other defects which would prevent it from producing the strength or accuracy and appearance necessary in the finished concrete surface. Wood or metal forms shall be constructed with mortar tight joints and of materials sufficient in strength to hold the concrete without bulging between supports. If the forms bulge or sag at any point when the concrete is placed in them, the portion of concrete causing the distortion shall be immediately removed and the forms properly repaired and strengthened before continuing the work.

In designing forms for concrete to be placed by ordinary hand methods freshly mixed concrete shall be treated as a liquid weighing 150 pounds per cubic foot for vertical loads and 85 pounds per cubic foot for horizontal loads. For concrete to be placed by vibration the concrete shall be treated as a liquid weighing 150 pounds per cubic foot for both vertical and horizontal loads, for the depth of concrete placed in any one run. Set concrete may be considered as weighing 150 pounds per cubic foot.

The unsupported length of wooden columns and compression members shall not exceed thirty times the dimension of the least side.

Wood forms for all exposed surfaces except wing walls parallel to the culvert barrel, the head walls therefor and such portions as may be completely covered by a single board, shall be lined with metal or with plywood, or hard pressed water resistant composition board not less than 3/16 inches thick. The joints in the lining shall be tight and smoothly cut and



shall break joints with the form lumber. Small irregular areas may still be formed with lumber against concrete to be rubbed, provided there is no joint in the lumber used on any flat surface of the concrete, except at angles, ribs, bevels, moulding, etc., where there is a juncture between two surfaces. Blocks, ribs, bevels, mouldings, etc., for ornamental effect on lined surfaces shall be placed inside the lining.

Forms shall be so designed and constructed that they may be removed without injury to the concrete. Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. The forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the plans and true to line and grade.

Forms shall be filleted at all sharp corners and should be given a bevel in the case of all projections such as girders, copings, etc., sufficient to insure their easy removal. Special attention must be paid to ties and bracing, and where the forms appear to be insufficiently braced or unsatisfactorily built, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected to his satisfaction.

To insure a first-class finish on the concrete, the forms shall be painted with a colorless oil, or some other satisfactory means taken to prevent the concrete from adhering to them. The forms should be thoroughly drenched with water immediately before the concrete is placed in them. Form lumber that is used a second time shall be thoroughly cleaned and shall be free from bulge, splits or warps.

**2403.23 REMOVAL OF FORMS.** In warm weather, forms may be removed in accordance with the following provisions, but in cool or unfavorable weather the Engineer may require the forms to remain in place for longer periods:

**A. Forms Which May Be Removed in Less Than 7 Days.**

Forms for ornamental work, railings, parapets and vertical surfaces may be removed whenever the concrete will not be damaged by so doing, but not less than 24 hours after the concrete is placed.

Forms for concrete in which high early strength Portland cement has been used may be removed as soon after the concrete has attained an age of 3 days as the concrete has developed the strength required by Article 2403.24-B.



**B. Forms Which Must Remain in Place 7 Days or Longer.**

Except as provided above, forms shall remain in place until the concrete has attained an age of 14 days, except that forms may be removed as soon after the concrete has attained an age of 5 days as the concrete has developed the strength required in Paragraph 2403.24-B.

Forms shall be removed from continuous concrete slabs, girders and rigid frame structures in accordance with the following provisions: The forms and supporting false-work shall be so removed that there is at least one span in which the concrete has attained the age or strength specified above, between the span from which the forms are about to be removed and any span in which the concrete has not attained the age or strength specified above.

**2403.24 SUBJECTING CONCRETE TO EXTERIOR LOADS.** Concrete may not be subjected to loads other than the weight of the concrete itself except as follows:

**A. Loads Producing Simple Compressive Stress Only.** Concrete may be subjected to simple compressive stress as soon as it has set sufficiently to prevent the surface being marred or the edges being chipped from the effect of such loads.

**B. Loads Producing Flexural Stresses.** Concrete shall not be subjected to exterior loads producing flexural stresses within 14 days after the concrete is placed, with the following exception:

Concrete may be subjected to loads due to backfilling or legal traffic as soon after 7 days as the concrete has developed a modulus of rupture of 450 pounds or more per square inch. The modulus of rupture shall be determined by testing as simple beams loaded at the center, specimens molded from the concrete used in that part of the structure in question and cured under the same conditions as the concrete in the structure.

**2403.25 JOINTS.** Unless otherwise provided in the detailed plans, the joints in concrete masonry shall be constructed in the following manner:

**A. Construction Joints.** Construction joints between successive layers of concrete shall be constructed in the manner as provided in Article 2403.15.



The location of important construction joints in the structure will be shown on the plans, but if the volume of concrete is too great to be placed without the use of additional construction joints they shall be so located and constructed as to impair the strength and appearance of the structure in the least possible manner. Construction joints shall be located in planes perpendicular to the principal lines of stress and at points of minimum shear.

**B. Expansion Joints.** Expansion joints shall be of the three general types as follows:

1. **Open Joints.** Open joints shall be placed in the locations as shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip or metal plate. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.
2. **Filled Joints.** Filled joints shall be constructed in the same manner as open joints and shall then be filled with a bituminous mastic or filler. When so specified on the plans or directed by the Engineer, a bituminous premoulded expansion joint of the required thickness shall be used in lieu of a template and shall remain in place to form the filler for the joint.
3. **Sliding and Friction Joints.** Sliding joints which are to be provided at the ends of slab, beam and girder bridges shall be composed of one sheet of premoulded bituminous expansion joint material cut to fit the area required and of the specified thickness. When not otherwise specified on the plans the thickness of the joint material shall be  $\frac{3}{8}$  inch.

**2403.26 SURFACE FINISH.** Concrete surfaces which will be exposed or be likely to be exposed after the structure is completed shall be finished in accordance with the provisions of this Article.

Concrete sidewalk and floors shall be finished in accordance with the provisions of Section 2411.

Horizontal surfaces not cast against a form and not subject to wear, such as bridge seats; the tops of back walls, piers,



abutments, wing walls, retaining walls, spandrel walls and struts between pedestral piers shall be given Class 1 Float Finish.

All exposed surfaces of concrete hand rails, rail posts and curbs shall be given Class 3 Rubbed Finish.

The following surfaces shall be given Class 2 Ordinary Surface finish: All surfaces exposed to view from any point on the roadway; the outside and lower surfaces of exterior girders, T-beams, projecting slabs, fascia girders, guard walls; all surfaces of cantilever beams, columns and sidewalk brackets; all exposed surfaces of spandrel walls, head walls, wing walls, retaining walls, abutments and piers. Abutments, piers and retaining walls located in or adjacent to water shall be finished to low water level, whether or not they are exposed to that level at the time the forms are removed. Piers, abutments and retaining walls when used in viaducts and other dry crossings or when so designed as not to extend to low water level, shall be finished to one foot below the finished ground line. Wing walls, spandrel walls and head walls shall be finished for a distance of one foot below the top on the inside face. In concrete structures to be used for highway grade separations the surfaces not listed in the foregoing statements which are exposed to view from the lower roadway shall be finished.

A. **Class 1, Floated Surface Finish.** The forms shall be over-filled with concrete. The concrete shall be struck off to the required elevation with a template. The surface shall then be thoroughly worked with a wood float until the surface is uniformly smooth, dense and true.

B. **Class 2, Ordinary Surface Finish.** Immediately after the removal of forms as provided in Article 2403.23, wires used as form ties shall be cut off flush with the surface of the concrete and driven back at least  $\frac{1}{4}$  inch below the surface. Rods and other devices used as form ties shall be removed to the extent contemplated in their design. Paper or fiber tubes used to facilitate the removal of rod ties shall be removed.

All fins and irregular projections shall be removed from the concrete surfaces required to be finished. On all surfaces the cavities produced by form ties and all other holes, honeycomb spots, broken corners and edges, and other defects shall be thoroughly cleaned and after being saturated with water, shall be carefully filled, pointed and trued with a mortar of cement and fine



aggregate of the same kind as that which was used in the concrete being finished. The entire surface required to be finished shall be cleaned of stains from form oil or other substances. The resulting surfaces shall be true and uniform.

All surfaces required to be finished which cannot be repaired to the satisfaction of the Engineer shall be finished as specified for Class 3 Rubbed Surface Finish.

All construction and expansion joints in the completed work shall be left carefully tooled and free from mortar and concrete. Expansion joint filler shall be left exposed for its full length and thickness and with clean, true edges.

- C. **Class 3, Rubbed Finish.** The rubbing of concrete shall be started as soon after the operations required for Class 2 Ordinary Finish as conditions will permit. The entire surface shall be rubbed with a Number 16 Carborundum brick used in combination with water. Rubbing shall be continued until the surface is covered with a coating of lather derived from the surface being finished. The resulting surface shall have a clean, uniform appearance, free from all signs of fins, projections, cavities and porous spots.

**2403.27 METHOD OF MEASUREMENT.** The volume of concrete masonry placed shall be computed in cubic yards by the Engineer, from dimensions shown on the plans, with such changes as have been made in accordance with written order of the Engineer. From this volume there shall be deducted 0.8 cubic foot for each lineal foot of concrete or wood piling projecting into footings or caps. No deductions from the volume of concrete shall be made for the volume of concrete displaced by the steel reinforcement. No deduction shall be made for the volume of concrete displaced by floor drains, expansion joints or metal strips for sealing joints. Additional concrete required to bring floors, curbs and hand rails to the required elevation shall not be measured for payment if such addition is made necessary by inaccuracies in the shape or placement of steel or distortion of falsework.

The weight of all steel expansion plates, castings of steel or iron and welded shapes for floor drains; bearing plates, rockers, anchor bolts, ice breakers and other steel parts, except steel reinforcement for concrete and metal fastenings therefor, will be included in the weight of structural steel.



**2403.28 BASIS OF PAYMENT.** The net volume of concrete masonry computed as specified in the preceding Article shall be paid for at the contract price per cubic yard, except as specified in the following provision. For concrete ordered by the Engineer to be protected or the materials heated, or both, in accordance with Article 2403.13, the contract price per cubic yard shall be increased by the following percentages:

Heating materials with no protection .....	5%
Protection of concrete with no heating of materials ..	10%
Heating materials and protection of concrete .....	15%

No extra compensation will be paid for the protection of concrete by flooding it with water.

These prices shall be full payment for furnishing all materials, including materials for filling and sealing joints, but not including structural steel or steel reinforcement; for furnishing, constructing and removing all forms, ties and falsework; for all mixing, handling, placing, finishing and protecting concrete; and for all work incidental thereto and necessary for the completion of the work in conformance with the plans and these specifications.

### Section 2404. Reinforcement

**2404.01 DESCRIPTION.** Reinforcement shall include all metal bars and fabric used in concrete for the purpose of resisting stresses transmitted to it through the concrete. The material used shall conform to the requirements of Section 4131.

**2404.02 CLEANING.** At the time it comes in contact with concrete, reinforcement shall be free from any coating other than soft red rust. It shall be free from loose mill scale, and sealy rust and from dirt, paint, oil, grease or other foreign substances. Any appreciable reduction in section caused by corrosion will be sufficient cause for the rejection of reinforcement.

**2404.03 BENDING.** Reinforcement shall be bent cold. It shall be bent accurately to the dimensions and shapes shown on the plans. In bending, care shall be taken not to injure the steel, and only proper appliances and competent workmen shall be employed on the work. Bars one inch or more in diameter shall be shop bent. Unless otherwise indicated, hooks on reinforcing bars shall have radii equal to four times the diameter



of the bar and the length of bar beyond the beginning of the bend shall be sixteen times the diameter of the bar.

**2404.04 STRAIGHTENING.** Reinforcement which may have become bent during shipment or handling shall be properly straightened before being placed in the work. The straightening shall be done without heating.

**2404.05 PLACING AND FASTENING.** Reinforcement shall be placed in the exact positions indicated on the plans and shall be held securely in place during the placing and hardening of the concrete. The location, fastening and condition of the reinforcement shall be inspected and approved by the Engineer before any concrete is placed around it.

In the floors of culverts and in other footings without piling, the reinforcement shall be suspended from cross wales above the top of the forms or shall be supported on steel stakes driven into the subgrade.

**2404.06 METAL SUPPORTS.** Except for vertical bars and bars which can be supported properly by being wired to vertical bars, all reinforcement for concrete slabs, girders, arches, floors, the barrels of arch and box culverts, footings above piles and all other parts of concrete structures where practicable, the reinforcement shall be supported on metal chairs approved by the Engineer.

Concrete block inserts, brick bats, stones, wood blocks, wood stakes and similar materials shall not be used for supporting reinforcement if the manner of their use is such that these materials are likely to become embedded in the concrete.

**2404.07 SPLICING.** Splicing of reinforcement at points of maximum stress shall be avoided. All splices of bar reinforcement shall lap at least 40 diameter of the bar.

**2404.08 METHOD OF MEASUREMENT.** The Engineer shall compute the weight of reinforcement from the theoretical weight of the nominal sizes and actual lengths of the various sizes of reinforcement shown on the plans. In case a greater or less quantity of reinforcement, than that shown on the plans, is ordered by the Engineer the quantity shall be re-computed from the theoretical weight of the reinforcement actually used.

**2404.09 BASIS OF PAYMENT.** The weight of steel reinforcement computed as specified above shall be paid for at the contract price per pound. This contract price shall be full



payment for furnishing and placing the reinforcement and such ties, metal supports and other supports as may be required to hold the reinforcement in proper position.

### Section 2405. Foundations and Substructures

**2405.01 DESCRIPTION.** Foundations and substructures shall consist of the bases or supports upon which superstructures rest including wings and railings therefor. They shall be built as specified on the plans and in accordance with the following provisions. The provisions of Sections 2401, 2402, 2403, 2404, 2414 and 2501 shall apply in addition to the provisions of this section. The requirements of this section shall not apply to culverts.

**2405.02 CONSTRUCTION OF COFFERDAMS.** In the construction of foundations and substructures, the cofferdams used shall be constructed in a substantial manner capable of satisfactorily resisting the earth or water pressures without appreciable displacement, and the Engineer may require the Contractor to furnish satisfactory evidence that the cofferdam will meet the requirements specified herein. On important bridges or on foundations carried to unusual depths, the Engineer may require the Contractor to submit detailed plans of cofferdams for his approval before construction of cofferdams is begun, but this approval shall not relieve the Contractor of responsibility for the results obtained.

Cofferdams shall be of sufficient height to prevent overflow from a reasonable rise of the stream and consequent damage and delay to the work.

When foundation soundings indicate porous or unstable material at the elevation of the bottom of the footing, except when the use of steel is specified on the plans, the cofferdam sheeting shall be either steel sheeting or dense southern pine not less than 3 inches thick grooved for splines. The sheeting shall be of such length that it may be driven to a depth which will cut off this unstable material from flowing into the excavation. The length of the sheeting shall be such that it may be driven at least 5 feet below the bottom of the footing. Cofferdams shall be strongly braced but no bracing shall be placed in such a manner as to be encased in the concrete of the structure except as provided in the following paragraph.

With the approval of the Engineer, structural steel bracing for cofferdams may be allowed to be encased in concrete at



elevations such that they will not be exposed in the finished structure and provided they will be cut off flush with the surface of the concrete. With the approval of the Engineer, small openings may be left in diaphragm walls and other thin sections to provide for cofferdam bracing, provided that such openings are so located as not to interfere with the structural integrity of the structure and are located in places where they can be filled later in a satisfactory manner. No cofferdam bracing shall be so placed as to bear against heavy concrete sections that have been in place less than 4 days in good weather. In the case of thin sections or unfavorable weather conditions, this period may be increased at the discretion of the Engineer.

A clear space of at least 18 inches shall be provided on all sides between the footing as shown on the plans and the cofferdam. In no case, except for seal coats, shall the cofferdam be used as a form for the concrete footing, but an independent form shall be built for the footing. A cofferdam may be used as the form for a seal coat. The sheeting of the cofferdam shall be of such a type and shall be so driven as to prevent as nearly as possible the entrance of water through the walls of the cofferdam. Pumps of sufficient capacity shall be provided to keep the excavation practically free of water until the concrete is in place.

**2405.03 SEAL COATS.** If the material encountered at the designed elevation of the bottom of the footing is so porous that water enters at such a rate that it is impractical to lower the water level to this elevation by pumping, or if the material is so plastic that it cannot be prevented from flowing into the excavation by driving sheeting to reasonable depths, the Engineer may require the Contractor to seal the cofferdam with concrete. The seal coat shall be placed below the elevation of the bottom of the footing. The seal coat shall consist of concrete of the class specified in Article 2405.05 and shall be placed in the manner prescribed in Article 2403.18.

After the placement of the seal coat the cofferdam shall not be unwatered until test beams as prescribed in Article 2403.24 show a modulus of rupture not less than 450 pounds per square inch.

**2405.04 FOOTINGS.** Footings shall be constructed as shown on the plans, or as ordered in writing by the Engineer. Piling will generally be used in all footings except those which rest upon solid rock or which have been carried below all possible



secure and are resting upon materials having satisfactory bearing values. Footings resting upon solid rock shall be anchored by carrying the footing at least 6 inches into the solid rock. All loose boulders and fragments of rock shall be removed and all open joints or seams in the rock shall be thoroughly cleaned and filled with concrete before the footing is placed.

No concrete shall be placed in a footing until the depth of excavation and the character of the foundation materials have been inspected and approved by the Engineer and the Engineer has given the Contractor permission to proceed.

**2405.05 CLASS OF CONCRETE.** All foundations and substructures, except filling for steel cylinder piers, shall be constructed of Class A concrete unless otherwise specified on the plans. The filling for steel cylinder piers shall be Class B concrete. Concrete in seal coats shall be Class A with 10% extra cement added to each batch.

**2405.06 PLACING CONCRETE.** The provisions of Section 2403 shall apply to all concrete placed in foundations and substructures. In reinforced concrete substructures the reinforcement extending into the footings shall be securely fastened in position and shall be inspected by the Engineer before any concrete is placed. Suitable wood or metal forms shall be used to enclose all footing concrete.

**2405.07 CONSTRUCTION JOINTS.** In general, each footing shall be constructed as a monolith. If construction joints are required, they shall be made as specified in Article 2403.15.

**2405.08 ICE BREAKERS.** Ice breakers shall be set true to alignment and with correct batter. The anchorage shall be in place before the concrete is placed. The ice breaker shall be considered as a part of the substructure.

**2405.09 SETTING ANCHOR BOLTS.** Unless specifically provided on the plans, anchor bolts for superstructures will not be set in piers and abutments at the time the concrete is placed. When anchor bolts are to be set during the placing of the concrete, they shall be held firmly in a rigid template which spans the concrete with sufficient clearance to permit proper finishing of the surface of the concrete. The template shall remain in place until the concrete has hardened. Anchor bolts shall be set accurately at points specified on the plans. Anchor bolts to be set at the time the concrete is placed shall



be furnished by the Contractor for the superstructure, but shall be set by the Contractor for the substructure.

**2405.10 FINISH.** Surfaces of concrete foundations and substructures shall be finished in accordance with the provisions of Article 2403.26.

**2405.11 PLACING SUPERSTRUCTURE.** The provisions of Paragraph 2403.24-A shall apply to the placing of superstructures on piers and abutments.

**2405.12 RECONSTRUCTION OF SUBSTRUCTURES.** When the work involves the reconstruction of an existing substructure to provide for the raising or lowering of an existing structure, the Contractor shall submit to the Engineer detailed plans for supporting the superstructure. The work shall not proceed until such plans are approved. Such approval shall not relieve the Contractor from responsibility for the results obtained. The points of support for the superstructure shall be selected to conform to the type of structure involved. Anchor bolts for steel structures shall not be pulled by lifting on parts of the main structure.

The superstructure shall be securely shored or guyed at all times while it is raised off the substructure to prevent overturning or slipping from the temporary supports.

**2405.13 STEEL CYLINDER PIERS.**

- A. **Depth.** Steel cylinder piers shall be placed at the elevations or depths as shown on the detailed plans. After placing the steel shell in exact alignment and in a vertical position it may be set to the proper depth by the use of water jets or by excavation from the interior of the steel shell.
- B. **Piling.** The excavation within the steel shell shall be completed to the required depth before the piling are driven. The piling specified shall be driven until the load carrying capacity and penetration required, as indicated on the plans, is obtained. The tops of the piling shall be sawed off at right angles to the axis of the steel cylinder pier. The piling shall project from 5 to 7 feet into the concrete.
- C. **Painting.** Before shipment to the work the entire exterior surface of the steel cylinder shall be given one coat of shop paint. After placing and filling, the exposed surface of the steel cylinder pier shall be given



two coats of field paint by the Contractor for the substructure. The painting shall be done in accordance with the requirements of Section 2508.

**2405.14 TIMBER SUBSTRUCTURES.** Timber substructures shall be composed of piling capped with timber, steel or concrete supporting the superstructure or framed bents upon which the superstructure rests. They shall be constructed in accordance with the requirements of Section 2408.

**2405.15 BASIS OF PAYMENT.** Foundations and substructures shall be paid for at the contract unit prices for the various items of Excavation for Structures, Piling, Concrete Masonry, Steel Reinforcement, Structural Steel, Timber, etc., as specified in the contract. These unit prices shall be full payment for furnishing all materials, equipment and labor and for performing all work necessary to the completion of the foundations and substructures in conformance with the plans and these specifications. Except when the contract provides a separate price for concrete seal coats, this item, including the 10% extra cement, will be paid for at the contract price for concrete masonry. The shells for steel cylinder piers shall be paid for at the contract price per pound for structural steel.

## Section 2406. Concrete Structures

**2406.01 DESCRIPTION.** The provisions of this section shall apply to all types of bridge structures in which the main members spanning the various supports are composed of concrete. The various types shall be constructed to conform to the detailed plans. The provisions of Sections 2403, 2404, 2411 and 2414 shall apply in addition to the following details.

**2406.02 CLASSES OF CONCRETE.** Unless otherwise specified Class A concrete shall be used in all parts of concrete structures, except handrails, lamp posts and such ornamental parts of the structure which shall be of Class C concrete.

**2406.03 FALSEWORK AND FORMS.** The construction of falsework and forms shall conform to the requirements of Articles 2403.21 and 2403.22. The Contractor shall notify the Engineer at least 24 hours before placing any concrete in the superstructure of a concrete bridge or above the skew back of an arch in order that the Engineer may inspect the false-



work and forms as to strength, alignment and general fitness. No concrete shall be placed until the falsework and forms have been approved by the Engineer. Such approval shall not relieve the Contractor from responsibility for results obtained. Falsework and forms shall provide for the full camber and roadway crown specified on the detailed plans.

Forms shall be removed in accordance with the provisions of Article 2403.23.

- A. **Arches.** Provisions shall be made for gradually lowering the centering of arches away from the arch ring at the time centering is struck. On important arches the Contractor may be required to so construct the centering that jacks of approved design may be employed to correct any slight settlement which may occur during the placing of the concrete.

**2406.04 PLACING CONCRETE.** Concrete shall be placed in accordance with the provisions of Section 2403 and the following details:

- A. **Placing Concrete in Slab Superstructures.** The concrete for each span shall be placed to its full depth in one continuous operation and without joints except as provided on the plans. The Contractor will be required to provide adequate material, labor and equipment to insure that the concrete required to be completed in a single continuous operation can be placed in 10 hours.
- B. **Placing Concrete in Deck Girder Superstructures.** Unless otherwise provided on the plans, the concrete for each girder shall be placed continuously for the entire length of the girder in level horizontal layers. The concrete for the floor shall be placed to the full required thickness in a single operation. The floor shall be placed as quickly as possible after the completion of its supporting girders and shall be completed within the same working day as the girders.
- C. **Placing Concrete in Arches.** The concrete above the skew backs of each arch ring shall be placed in one continuous operation if this is possible. If the volume of concrete involved is so great as to make this impossible the arch ring may be divided into sections as described below.

The division of arch rings into appropriate sections will ordinarily be indicated on the plans. The arch



ribs of open spandrel arches may be divided into radial segments. The barrels of spandrel filled arches may be divided into longitudinal rings by headers parallel to the reinforcement extending across the span. In either case the arrangement of sections shall be approved by the Engineer before being adopted.

The outer surfaces of arch rings or ribs shall be formed to a point where the slope of the surface is such that the concrete will stand without slumping. This slope will generally be less than  $30^\circ$  with the horizontal.

Under any scheme of placing the concrete in an arch ring, whether monolithic or in sections, the operation shall be so conducted as to load the centering symmetrically and any section once begun shall be completed before operations cease.

Should a breakdown cause unavoidable delay, the concrete already in place shall be finished to intermediate headers to divide the arch as indicated above.

Each wing wall, spandrel wall or spandrel column, shall be placed in one continuous operation except as indicated on the plans.

The spandrel walls for any spandrel filled arch with a high fill and with a rise equal to or greater than half the span may be placed before the centering of the arch is removed. The centering of all other arches, including open spandrel arches, shall be removed before the concrete for the handrails, spandrel walls, copings or posts is placed.

**2406.05 JOINTS.** Joints shall be constructed in the locations shown on the plans and in the manner specified in Article 2403.25. Special joints in arches such as mortise and slip joints shall be constructed as shown on the plans.

**2406.06 DRAINAGE.** Transverse drainage of floors of concrete superstructures shall be provided by means of crown in the roadway surface. Floor drains shall be neatly constructed and placed at the locations shown on the plans. The drains over arch rings and behind abutments, wing walls and similar structures shall be installed in accordance with the provisions of Section 2502.

**2406.07 WATERPROOFING.** The extrados of spandrel filled arches shall be waterproofed or dampproofed as indicated on



the plans and in accordance with the provisions of Section 2510.

In case membrane waterproofing is not covered promptly with earth the waterproofing shall be whitewashed to reduce the absorption of heat from the sun.

**2406.08 SURFACE FINISH.** Concrete superstructures shall be finished in accordance with the provisions of Article 2403.26. The extrados surfaces of spandrel filled arches shall be given a Class 1 float finish. Concrete floors shall be finished in accordance with the provisions of Section 2411.

**2406.09 BASIS OF PAYMENT.** All concrete bridge structures will be paid for at the contract unit prices for Concrete Masonry, Steel Reinforcement, Structural Steel, Waterproofing or Dampproofing, etc., as specified in the contract. These unit prices shall be full payment for furnishing all materials, equipment, labor and the performance of all incidental work necessary to complete the structures in conformance with the plans and these specifications.

No deduction will be made for the volume of concrete displaced by floor drains, expansion joints or metal strips for sealing joints. The cost of all bituminous expansion joint material, metal strips for sealing joints and other small miscellaneous items shall be included in the price per cubic yard for concrete masonry. The weight of structural steel paid for shall include all steel expansion plates, castings of steel or iron, or welded shapes for floor drains; bearing plates, anchor bolts and other steel parts except steel reinforcement for concrete and the metal fastenings therefor.

## Section 2407. Steel Structures

**2407.01 DESCRIPTION.** The provisions of this section shall apply to the fabrication and erection of all types of bridge structures in which the main members spanning the various supports are composed of steel. The various types of structures shall be built in accordance with the plans and the approved shop drawings. In addition to the provisions of this section, those of Sections 2403, 2404 and 2411 shall also apply.

**2407.02 CHANGES AND SUBSTITUTIONS.** Attention is called to the provisions of Article 1105.03. Sections other than those shown on shop drawings approved by the Engineer may be used under the following provisions: (a) That the substitute



section is equal in strength and stiffness to the section originally shown; (b) That the substitution is approved by the Engineer; and (c) That the substitution is made at no additional cost to the County.

**2407.03 WORKMANSHIP AND FINISH.** The workmanship and finish shall be first-class in all respects 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. If flame cuts are made all burnt metal burrs shall be removed by chipping. Any rough flame cut surface exposed to view shall be smoothed by milling, planing or grinding. Wherever the change in section due to a re-entrant cut may cause critical stress, such re-entrant cut shall be filleted to a radius not less than  $\frac{3}{8}$  inch before cutting.

**2407.04 MATERIALS.** The base materials required in steel structures shall conform to the requirements of the following as set forth in Part IV.

- A. Rolled plates, shapes and eyebars, Section 4132.
- B. Rivets, Section 4133.
- C. Forgings and castings, Section 4134.
- D. Bronze metal (rolled or cast), Article 4149.03.

**2407.05 BOLTS AND NUTS.** Bolted connections shall not be used except as indicated on the plans or approved by the Engineer for each specific connection. Where bolted connections are shown on the plans the bolts used may be unfinished bolts unless otherwise indicated. Finished bolts or ribbed drive fit bolts shall be used as required by the plans.

- A. **Unfinished Regular Bolts and Nuts.** Unfinished regular bolts and nuts shall conform to the requirements of Federal Specifications for Bolts, Nuts, Studs, and Tap Rivets FF-B-571a, Class C steel. The threads shall be as hereinafter specified. Bolt heads and nuts shall be hexagonal. Screw threads shall have Class 2 free fit and shall conform to the American National coarse thread series except that bolts having diameters greater than  $1\frac{1}{2}$  inches shall have 6 threads per inch. Each bolt shall be fitted with one S.A.E. Standard Regular lock washer under the nut.

The length of bolts shall be not less than the thickness of the metal to be gripped plus the thickness of the



washer plus the thickness of the nut, nor greater than this length plus  $\frac{1}{4}$  inch. Bolts which are intended to transmit calculated shearing stress shall be threaded to such length that none of the thread will be within the grip of the metal.

The number of bolts of each size and length furnished shall be 5% greater than the actual number shown on the plans.

- B. Finished Bolts and Nuts.** Finished bolts and nuts shall conform to the requirements of Federal Specifications for Bolts, Nuts, Studs, and Tap Rivets FF-B-571a except that rolled threads will not be acceptable. Bolt heads and nuts shall be hexagonal regular. Bolts and nuts shall be threaded Class 3 medium fit conforming to the American National coarse thread series except that bolts having diameters greater than  $1\frac{1}{2}$  inches shall have 6 threads per inch. Each bolt shall be fitted with a plain washer  $\frac{1}{4}$  inch thick and having a hole the same size as the drilled or reamed hole in which the bolt is used. The length of bolts shall be not less than the thickness of the metal to be gripped plus the thickness of the washer plus the thickness of the nut nor greater than this length plus  $\frac{1}{4}$  inch. Bolts shall be threaded to such length that the metal will be gripped tightly with none of the thread within the grip of the metal. The number of bolts furnished shall be 5% greater than the actual number shown on the plans.

- C. Ribbed Bolts.** Ribbed bolts shall be of approved style and manufacture with button heads and self-locking nuts. The bolts shall be of proper grip and length and shall be a standard commercial product.

**2407.06 RIVETS.** The diameter of rivets shown on the plans shall be understood to be the diameter of the rivet before heating. Rivet heads shall be of a shape approved by the Engineer and concentric with the shank. Field rivets shall be carefully selected and shall be free from furnace scale on the shanks and from fins on the under side of the heads. The number of field rivets furnished shall be in excess of the nominal number required by 10% for each size and length.

**2407.07 EYEBARS.** Eyebars shall be straight, true to size and free from twists, folds in the neck and head, and from other defects. Heads shall be made by upsetting and rolling



or forging. Welds will not be permitted in the head or the body of the bar. The form of the heads will be determined by the dies in use at the works where the eyebars are made if this form is satisfactory to the Engineer. The thickness of head and neck shall not overrun more than 1/16 inch.

Before being bored, eyebars shall be properly annealed and carefully straightened. Pin holes shall be located on the center line of the bar and in the center of the heads.

Bars shall have both ends bored at the same time and shall be bored so accurately that when the bars of the same length are placed together, pins 1/32 inch smaller in diameter than the pin holes can be passed through the holes at both ends at the same time without driving.

**2407.08 PINS AND ROLLERS.** Pins and rollers shall be accurately turned to the specified dimensions and shall be smooth, straight and free from flaws.

Pins and rollers more than 7 inches in diameter shall be forged and annealed.

Forgings for pins larger than 9 inches in diameter shall have a hole not less than 2 inches in diameter bored longitudinally through their centers after the forging has cooled below the critical range and before the forging is annealed. Pins showing a defective interior condition shall be rejected.

**2407.09 SHOP STORAGE OF MATERIAL.** Structural material, either plain or fabricated, shall be stored above ground upon platforms, skids or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion so far as is practicable.

**2407.10 STRAIGHTENING MATERIAL AND PLACING MEMBERS.** All rolled material must be straight when it is laid off or worked. If straightening is necessary, it shall be done by means which will not injure the metal. Sharp kinks or bends will be sufficient cause for the rejection of the material. Unless otherwise shown on the plans or ordered by the Engineer, members which deviate from a straight line by an amount within the specified tolerance shall be so placed in the structure that the stress to be imposed will tend to straighten the member.

**2407.11 BENT PLATES.** Cold bent load carrying plates shall conform to the following requirements.



- A. The radius of bends measured to the concave face of the metal shall not be less than that shown in the following table where "T" is the thickness of the plate in inches:
- | Angle Through Which Plate Is Bent | Minimum Radius |
|-----------------------------------|----------------|
| 61° to 90°                        | 1.0 T          |
| 91° to 120°                       | 1.5 T          |
| 121° to 150°                      | 2.0 T          |

- B. Before the plate is bent, its corners shall be rounded to a radius of 1/16 inch throughout that portion of the plate at which bending is to occur.

**2407.12 EDGE PLANING.** Sheared edges of material having a thickness greater than 5/8 inches and designed to carry calculated stress shall be planed to a depth of 1/8 inch wherever such planing is indicated on the plans. Re-entrant cuts shall be filleted before cutting.

**2407.13 FLAME CUTTING.** Steel may be flame cut provided a smooth surface is secured by the use of a mechanical guide approved by the Engineer. Flame cutting by hand shall be done only with the specific approval of the engineer and provided the surface is made smooth by chipping and planing or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than 1/2 inch. A flame shall not be used for cutting rivet holes for either shop or field rivets nor for the removal of rivets.

**2407.14 WELDING.** Welding of steel structures shall be done only at locations shown on the plans. Welding may be substituted for riveting only with the specific written approval of the Engineer. All welding shall conform to the requirements of the Specifications for welded Highway and Railway Bridges of the American Welding Society. All spatter, slag and flux deposits caused by welding shall be removed whether or not the surface is to be painted.

**2407.15 ANNEALING.** All eyebars, forged pins and other steel parts whose full strength is required and which have been heated in the process of forming or fabrication shall be subsequently annealed. The parts shall be heated uniformly to the proper temperature and cooled slowly and uniformly in the furnace. The temperature of the parts shall be under full control at all times and proper instruments shall be provided



for determining the temperature of the parts at any time. Web stiffeners will not be required to be annealed.

**2407.16 PLATE GIRDERS.** Plate girders shall be fabricated in accordance with the following requirements.

- A. **Web Plates.** Web plates of girders having no cover plates, unless otherwise shown on the plans, shall be fabricated with the top edge of the web flush with the back of the flange angles. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be  $\frac{1}{2}$  inch less in width than the distance back to back of flange angles. When web plates are spliced, not more than  $\frac{3}{8}$  inch clearance between the ends of plates will be allowed.
- B. **Web Stiffeners.** End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be machined to secure a uniform even bearing against flange angles, or they may be welded provided the flange is not to be subjected to tensile stress greater than 75% of its capacity. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted.
- C. **Web Splices and Fillers.** Web splice plates and fillers under stiffeners shall fit within  $\frac{1}{8}$  inch at each end.
- D. **Camber.** The camber of plate girders, measured at mid-span, shall not vary from that shown on the plans by more than  $\frac{1}{4}$  inch.

**2407.17 CAMBER OF BEAM SPANS.** Rolled beams constituting the main supporting member of a span shall be cambered in accordance with the following requirements. Where specified on the plans, rolled beams shall be cambered to an approximate circular curve throughout or between designated points. At mid-point of camber the camber shall not be less than that specified nor more than that specified plus  $\frac{1}{2}$  inch. At quarter points of cambered length the camber shall not be less than that specified nor more than that specified plus  $\frac{3}{8}$  inch. Cambered beams shall be free from kinks, buckles or other localized imperfections.

**2407.18 RIVET HOLES.** All holes for rivets shall be either punched or drilled. Holes in material  $\frac{3}{4}$  inch or less in thickness may be punched  $\frac{1}{16}$  inch larger than the nominal diam-



eter of the rivets. Holes in material more than  $\frac{3}{4}$  inch in thickness shall be subpunched and reamed or shall be drilled from the solid. Except as provided above or otherwise required on the plans, all rivet holes may be punched full size.

A. **Punched Holes.** Full size punched holes shall be  $\frac{1}{16}$  inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than  $\frac{1}{16}$  inch. Holes must be cleancut without torn or ragged edges.

The punching of the 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 hole may be passed through at least 75% of the holes without reaming. If this requirement is not fulfilled the badly punched pieces shall be rejected. If any hole will not pass a pin  $\frac{3}{16}$  inch smaller than the nominal diameter of the hole this also shall be cause for rejection.

B. **Subpunched and Reamed Holes.** Subpunched and reamed holes for rivets having diameters greater than  $\frac{3}{4}$  inch shall be punched  $\frac{3}{16}$  inch smaller than the nominal diameter of the rivet. For rivets having diameters  $\frac{3}{4}$  inch and less the holes shall be punched  $\frac{1}{16}$  inch less than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full size punched holes.

After the holes have been punched and the parts have been assembled the holes shall be reamed to a diameter  $\frac{1}{16}$  inch larger than the nominal diameter of the rivets. Burrs produced by reaming shall be removed with a tool which produces a  $\frac{1}{16}$  inch fillet around the edge of the hole.

The reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers shall be directed by mechanical means where this is practicable.

Reamed holes shall be cylindrical and perpendicular to the member. The accuracy of reamed holes shall be the same as that specified for punched holes except that after reaming 85% of the contiguous holes in any surface shall show no offset greater than  $\frac{1}{32}$  inch between adjacent thicknesses of metal.

C. **Drilled Holes.** Drilled holes shall be  $\frac{1}{16}$  inch larger than the nominal diameter of the rivets. Burrs on the



outside surfaces shall be removed with a tool which produces a 1/16 inch fillet around the edge of the hole.

The accuracy of drilled holes shall be the same as specified for subpunched and reamed holes in Paragraph B of this Article.

**2407.19 REAMING SUBPUNCHED HOLES.** When subpunched and reamed rivet holes are required the main members of the structure shall be fully assembled and firmly bolted together and their members adjusted to line and fit before the holes in the connecting joints are reamed. Before the parts are dis-assembled for shipping and handling, the respective pieces shall be match-marked so that they can be re-assembled in the same position when the structure is erected in the field.

Reamed parts shall not be interchanged. The connecting joints such as floor beam and stringer connections not assembled as provided above shall be reamed to a metal template.

**2407.20 SHOP ASSEMBLY.** The various parts of the structure which are to be fastened together in the shop shall be assembled in accordance with the following:

The surfaces which will be in contact when assembled shall be carefully cleaned and free from loose mill scale, dirt or other foreign material. Contact Surfaces need not be painted. Surfaces which are not to be in contact which are accessible before erection but which will be inaccessible after erection shall be painted in the shop with all the coats of paint required on the completed structure. The inside surfaces of pipes and similar sections shall be covered with one coat of shop paint by dipping. Surfaces designed to be in bond with concrete shall not be painted. Machined surfaces with small clearances, such as full circle pins and pin holes, shall be coated with white lead and tallow applied hot as soon as the surfaces have been finished and approved.

The component parts of a built-up member shall be assembled, drift pinned to prevent lateral movement, and firmly bolted to draw the parts into close contact before reaming, drilling or riveting is begun. Assembled parts shall be dis-assembled, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends or other deformations.

Full sized punched rivet holes shall be spear-reamed before riveting is begun if such reaming is necessary to insure the



free admission of the rivets. This requirement shall not affect the accuracy requirements of Article 2407.18.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped or otherwise held firmly in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts, in so far as practicable, to prevent damage in handling and shipment.

**2407.21 DRIFTING OF RIVET HOLES.** The drifting done during assembling shall be only such as to bring the parts in position and not sufficient to enlarge the holes or distort the metal.

**2407.22 SHOP RIVETING.** Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. When a rivet is ready to be driven it shall be free from slag scale or other adhering matter, and when driven it shall fill the hole completely. Burned, burred or otherwise defective rivets or rivets which throw off sparks when taken from the furnace or forge shall not be driven.

All rivets that are loose, badly formed or otherwise defective shall be removed and replaced with satisfactory rivets. Caulking or recupping of rivet heads will not be permitted. In removing defective rivets care shall be taken to avoid injury to the adjacent metal and if necessary the rivet shanks shall be removed by drilling.

Shop rivets shall be driven with direct acting riveting machines where practicable. The riveting machine shall retain the pressure for a short time after the upsetting is completed. When the use of a direct acting riveting machine is not practicable, pneumatic hammers of approved size shall be used.

Heads of driven rivets shall be of approved shape, concentric with the shanks, true to size, full, neatly formed, free from fins and in full contact with the surface of the member.

Countersinking shall be neatly done and countersunk rivets shall fill the holes completely.

**2407.23 FACING BEARING SURFACES.** The ends of columns and pedestals shall be milled to true surfaces and correct bevels. Warped or deformed base and cap plates shall be planed to fit accurately.

Connection angles for base and cap plates shall be riveted to columns before the ends are faced. Milling shall be done only after the member has been fully riveted.



The bearing surfaces of warped or deformed base and cap plates that are not to be placed in contact with masonry shall be milled after the plates are riveted to the column. Surfaces of base plates that are to be placed in contact with masonry shall be free from warps and other deformations.

Sole plates of beams, girders and trusses shall have full contact with the flanges and the bearing surface shall be smooth and true and shall be truly perpendicular to the web of the member. Curved sole plates shall make full line bearing with masonry plates, which line shall be at right angles to the axis of the beam, girder or truss and with the web of the member. The top surfaces of masonry plates shall be flat and smooth. Their bottom surfaces shall be free from warps and projections. Cast pedestals shall be planed on the surface to be in contact with steel and all warps and projections shall be removed from the surface to be in contact with masonry.

Surfaces of bronze bearing plates intended for sliding friction shall be smooth.

In planing expansion bearings the cut of the tool shall be in the direction of the expansion.

#### 2407.24 ABUTTING JOINTS.

- A. **Ends of Compression Members.** The abutting ends of compression members shall be accurately faced after the members are riveted to secure an even bearing when assembled in the structure.
- B. **Ends of Tension Members.** The ends of tension members shall be neatly sheared at splices to secure close fitting joints without contact.

**2407.25 END CONNECTION ANGLES.** End connection angles of floor beams and stringers shall be flush with each other and accurately set as to position and length of member. In general, end connection angles shall not be machined unless so indicated on the plans. However, faulty assembling and riveting may be cause for requiring them to be milled, in which case their thickness shall be reduced not to exceed 1/16 inch, nor their rivet bearing value reduced below the design requirements.

**2407.26 BORING 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 1/16 inch. Boring of holes in built-up members shall be done after the riveting is completed.

**2407.27 PIN CLEARANCE.** The difference in diameter between the pin and the pin hole shall be 1/32 inch.

**2407.28 FINISHED MEMBERS.** The several pieces forming one built member shall be straight and close fitting. Finished members shall be true to detailed dimensions and free from twists, bends, open joints, or other defects resulting from faulty fabrication and workmanship.

**2407.29 SHOP ERECTION.** Unless otherwise indicated on the plans each individual truss and each individual line of girders or beams for continuous spans shall be completely assembled for inspection in the shop. The complete shop erection of an entire structure, including floor system, which may be necessary in case of complicated designs, will be required if so indicated on the plans.

After alignment, accuracy of punched holes and milled joints have been inspected and approved, all full sized punched holes for field rivets shall be spear reamed. Before the structure or part of structure is dis-assembled all members shall be conspicuously match-marked on patch painted surfaces. The Engineer shall be furnished with diagrams showing such marks if these have not been shown on the shop drawings.

**2407.30 PILOT AND DRIVING NUTS.** On pin connected spans, pilot and driving nuts shall be furnished for each size pin unless otherwise provided on the plans.

For riveted spans where shoes are pinned to bottom chord sections or bolster, no pilot or driving nuts need be furnished.

**2407.31 MILL AND SHOP INSPECTION.** The Contractor shall give the Engineer ample notice of the beginning of work at the mill and shop so that inspection may be provided. In the event that inspection of the rolling is waived, the Engineer shall be furnished with complete test reports of mill inspection, showing chemical analysis and physical tests for each melt as required in Section 4132.

No material shall be fabricated before the Engineer has been notified where the orders have been placed.



A. **Inspector's Authority.** The Inspector shall have the power to reject materials or workmanship which does 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 Contractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing the same.

B. **Facilities for Inspection.** The Contractor shall furnish all facilities for inspection of material and workmanship in the mill and shop, and Inspectors shall be allowed free access to the necessary parts of the premises.

C. **Mill Orders and Shipping Statements.** The Contractor shall furnish the Engineer with as many copies of mill orders and shipping statements as may be requested. The weights of the individual members shall be shown.

D. **Rejection.** The acceptance of any material or finished members by the Inspector shall not be a bar to their subsequent rejection if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

**2407.32 SHOP PAINTING.** After the steel has been fabricated it shall be cleaned and shop painted in accordance with the provisions of Section 2508.

**2407.33 MARKING AND SHIPPING.** Members weighing more than three 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 the 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 in advance of the masonry construction if so required.



**2407.34 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 may be inspected upon its delivery to the site of the work.

**2407.35 FIELD HANDLING AND STORAGE.** The loading, transportation, unloading and piling of structural members shall be so conducted that the metal will be kept clean and free from injury by rough handling.

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. Girders and beams shall be placed upright and shored. The skids beneath long members, such as columns or chords, shall be close enough together to prevent injuring the members by deflection.

**2407.36 ERECTION.** Steel structures shall be erected in accordance with the following provisions:

- A. **Falsework.** Unless otherwise provided, detailed plans for falsework or centering shall be supplied to the Engineer upon request, but in no case shall the Contractor be relieved of responsibility for results obtained by the use of these plans. The adequacy of falsework for the purpose in view shall be subject to checking and approval by the Engineer before erection of the structure which the falsework is to carry. Falsework for supporting steel during erection shall be designed to carry without appreciable settlement or deformation the full load coming upon it. It may consist either of full length pile bents or framed bents supported by piles or spread footings. The bearing values of the piles shall be determined as provided in Article 2501.13, and shall be at least equal to the loads imposed upon them during construction. The number and size of spread footings or mudsills used shall be determined by the load to be supported and the bearing value of the soil on which they rest, due consideration being given to the softening of soils during high water, thawing of frozen ground, etc. Mudsills shall not be used on soils or in situations where scour is likely to occur.

The safe bearing value of sand, gravel, firm clay and



other similar confined materials in thick beds shall be considered 2 tons per square foot.

If necessary to extend falsework above the elevation to which piles are driven, all piles in any bent shall be cut off at the same elevation and capped, and a framed bent constructed to the required height. Each falsework bent shall be capped transversely at the proper elevation with timber of adequate size securely bolted or drifted to each pile or post in the bent. All bents shall be securely braced longitudinally and transversely with diagonal bracing.

- B. **Preparation of Bearing Area.** Column bases, truss and girder pedestals and shoes shall have a full uniform bearing upon the masonry of the substructure. Bridge seats of piers or abutments which are improperly finished, deformed or irregular within the bearing area of masonry plates shall be corrected before the plates are placed. The pedestals and shoes for truss and girder spans and the columns for steel viaducts shall be placed on layers of canvas and first field coat paint prepared as follows:

The top surface of the bridge seat shall be thoroughly painted. Upon the painted surface shall be placed three layers of 12- to 14-ounce duck swabbed freely with paint between the successive layers. The shoe or pedestal for the superstructure shall be placed while the paint is plastic.

- C. **Handling Members.** The component parts of a structure shall be handled by methods and appliances not likely to produce injury to the member by twisting, bending or otherwise deforming the metal. No member that is slightly bent or twisted shall be put in place until its defects are corrected. Members that have been seriously damaged in handling may be rejected.
- D. **Alignment.** Before beginning the field riveting the structure shall be adjusted to correct grade and alignment and the elevations of panel points (end of floor beams) properly regulated.
- E. **Straightening Bent Material.** The straightening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture. The metal shall not be heated unless permitted by the Engineer, in which case the metal shall not be heated to a higher



temperature than that producing a dark cherry red color and it shall be cooled as slowly as possible.

Following the completion of the straightening of a bend or buckle, the surface shall be carefully inspected for evidence of fracture. Members showing fracture shall be repaired or replaced.

- F. Assembling and Riveting.** All field connections and splices shall be securely drift-pinned and bolted before riveting. Important connections in trusses, girders, floor systems, etc., shall have at least 25% of the holes filled with drift pins and 25% of the holes filled with bolts drawn up snugly. At milled connections of compression chords of truss spans, except the hip connection, the number of drift pins may be reduced to not less than 10% of the number of holes. The number of drift pins used shall be sufficient to prevent slipping at joints and splices.

The results obtained in field assembling and riveting of the members of a structure shall fulfill the requirements for shop assembling and riveting. All field driven rivets shall be inspected and any found to be loose or defective shall be cut out and replaced with satisfactory rivets before the first field coat of paint is applied. Field riveting shall be done while the steel is supported on the falsework, unless specific permission to the contrary is granted by the Engineer.

- G. Bolting.** Bolted connections shall not be used except as indicated on the plans or approved by the Engineer for each specific connection. The bolts used shall conform to the requirements of Article 2407.05.

1. The holes for finished bolts shall be carefully reamed to a driving fit with the bolt.
2. The holes for ribbed bolts shall be carefully reamed to a driving fit with the bolts. The holes shall be cylindrical and at right angles to the surfaces that are to be held together. Where the bolts are to be used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut.

Bolts shall be driven accurately into the holes without damaging the threads. A snap shall be used to prevent damage to the head.

The heads and nuts shall be drawn tight against the work with a suitable wrench not less than 15 inches



long. Bolt heads shall be tapped with a hammer while the nut is being tightened.

Ribbed bolts shall be used in nominal sizes not smaller than the rivets for which they are substituted. They shall be furnished in a sufficient variety of lengths that when drawn tight the fluted shank will fill the hole in the work and the thread will completely fill the nut with not more than one thread protruding.

If for any reason the bolts twist before being drawn tight the hole shall be carefully reamed and the bolt replaced with a new bolt having a diameter which will fit the reamed hole properly. The Contractor shall provide oversize bolts for such replacements in a number not less than 10% of the number of ribbed bolts specified.

**H. Adjustment of Pin Nuts.** All nuts on pins shall be thoroughly tightened and the pins so located in the hole that the members shall take full and even bearing upon them.

**I. Setting Anchor Bolts.** When so provided on the plans anchor bolts shall be set in the fresh concrete of the substructure in accordance with the provisions of Article 2405.09. Except as provided in the preceding sentence anchor bolts shall be set in the following manner.

Holes having diameters approximately twice that of the anchor bolts shall be drilled at the proper locations in the concrete of the substructure. They shall be drilled to the required depth and perpendicular to the plane of the bridge seat. The bolts shall be set in mortar composed of one part Portland cement and one part sand, with sufficient water to render it readily workable.

Anchor bolts shall first be dropped into the dry holes to assure proper fit after setting. They shall then be set as follows: The hole shall be filled to about two-thirds of its depth with mortar. The bolt shall then be forced into the mortar by a uniform pressure or by light blows of a hammer until the bolt is forced down to the required elevation. All excess mortar that may have been forced out of the hole shall be removed to permit proper field painting of metal surfaces.

The location of anchor bolts in relation to slotted holes in expansion shoes shall be varied to compensate for the temperature of the structure. The nuts on anchor bolts



at the expansion ends of spans shall be so adjusted as to permit the movement of the span with changes in temperature.

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 templates or other suitable means. Such anchor bolts shall be furnished by the Contractor for the superstructure and set by the contractor for the substructure.

**J. Setting Rocker Bearings.** Rocker bearings at expansion end of spans shall be adjusted to provide for movement due to temperature, elongation of bottom chord and probable substructure movement. The mean temperature shall be assumed 50° F. in reckoning temperature movements.

**K. Swinging the Span.** Before concrete is placed in the floor of steel spans the centering shall be struck and the span swung free on its permanent supports.

**2407.37 PAINTING.** Unless otherwise specified all structural steel will be given one coat of paint in the shop and two coats after erection in the field. The material of the various coatings, the preparation of the surfaces and application of the paint shall conform to the requirements of Section 2508. Both cleaning and painting will be inspected after the fabrication and again after erection.

**2407.38 METHOD OF MEASUREMENT.** The quantities of the various items of concrete masonry, steel reinforcement, structural steel, etc., involved in the construction of steel structures will be computed by the Engineer in accordance with the provisions of the Article applying to these respective items as follows:

- A. Concrete masonry, Article 2403.27.
- B. Steel reinforcement, Article 2404.08.
- C. Structural steel and incidental metal parts, this Article.
  - 1. **Structural Steel.** The weight of structural steel shall include the net weight of all rolled shapes and plates as fabricated, and incidental parts such as castings, bearing plates, expansion devices, bolts, rivets, etc., necessary to the completion of the structure. Unless the contract contains a separate item for metal railings, the material for such railings shall be included



with structural steel. Incidental materials such as bronze, wrought iron, lead, castings, etc., shall be classed as structural steel unless covered by a separate item in the contract. Reinforcing steel for concrete is not included in this item.

2. **Weight to be Paid For.** The weight of structural steel as defined above for which payment will be made shall be the net weight computed by the Engineer as shown on the plans. In the case of a substitution of a heavier section than that shown on the plans the weight of the original section shall be the quantity paid for.
3. **Variation in Weight.** If the weight of any member less than 97.5% of the computed weight such member may be rejected.
4. **Computed Weight.** The Engineer will compute the weight of structural steel on the basis of the following assumptions as to the weights per cubic foot:

Steel .....	490 pounds
Cast Iron.....	450 pounds

The weight of rolled shapes and of plates 36 inches and less in width shall be computed on the basis of their nominal weights and dimensions as shown on the plans, deducting for copes and cuts.

To the weights of plates wider than 36 inches computed from the dimensions as shown on the plans, deducting for copes and cuts, there shall be added one-half the allowable percentage of overrun in weight given in the A.S.T.M. Standard Specifications for Steel for Bridges and Buildings A-7.

The weights of heads of shop driven rivets shall be included in the computed weight assuming these weights to be as follows:

Diameter of Rivet	Weight of 100 Heads
$\frac{1}{2}$ inch .....	4.0 pounds
$\frac{3}{8}$ inch .....	7.0 pounds
$\frac{1}{4}$ inch .....	12.0 pounds
$\frac{3}{8}$ inch .....	18.0 pounds
1 inch .....	26.0 pounds
$1\frac{1}{8}$ inch .....	36.0 pounds
$1\frac{1}{4}$ inch .....	48.0 pounds



The weights of welds shall be included in the computed weight, assuming the weights of fillet welds to be as follows:

Size of Weld	Weight per Lineal Foot
$\frac{1}{4}$ inch .....	0.20 pounds
$\frac{5}{16}$ inch .....	0.25 pounds
$\frac{3}{8}$ inch .....	0.35 pounds
$\frac{1}{2}$ inch .....	0.55 pounds
$\frac{5}{8}$ inch .....	0.80 pounds
$\frac{3}{4}$ inch .....	1.10 pounds

The computed weight shall include the total weight of field rivets as specified in Article 2407.06, and of all shims required to be furnished for incorporation in the structure.

The weight of castings shall be computed from the dimensions shown on the plans with an addition of 5% for fillets and overrun.

To the total computed weight of metal shall be added 0.4% for shop paint.

**2407.39 BASIS OF PAYMENT.** Steel structures will be paid for at the contract unit prices for concrete masonry, steel reinforcement, metal railing and structural steel. These unit prices shall be full payment for furnishing all materials; preparation, including fabrication; transportation, erection, together with furnishing all labor, equipment and incidentals to complete the structure, including the painting of the completed structure in accordance with the plans and these specifications.

### Section 2408. Timber Structures

**2408.01 DESCRIPTION.** This section shall apply to the construction of structures composed wholly of timber or of timber combined with structural steel or concrete. The provisions of Sections 2401, 2402, 2403, 2404, 2405, 2407, 2501, 2508 and 2509 shall apply to the various phases of the construction. The timber portions of the structure shall be built to conform to the detailed plans and these specifications.

**2408.02 MATERIALS.** All materials used in timber construction shall conform to the requirements of Part IV for the respective material as follows:

A. **Timber and Lumber.** Untreated structural parts to be painted shall be furnished S4S. All stringers shall



be surfaced 2 edges. All other sawed timber shall be furnished rough unless otherwise specified.

1. Untreated structural parts Class A ..... Section 4138
2. Untreated non-structural parts S4S,  
Class C ..... Section 4138
3. Treated timber, Class B ..... Section 4139
4. Piling ..... Section 4142

#### B. Steel.

1. Steel rods for tension members and all  
plates and structural shapes ..... Section 4132
2. Steel reinforcement for concrete ..... Section 4131

C. Paint ..... Section 4135

D. Creosote ..... Article 4136.01

E. Plastic Cement ..... Paragraph 4120.02F

F. Hardware. All hardware shall be of standard quality. All bolts, rods, nails, lag screws, washers and nuts (except female threads) which are to be used through or in contact with treated timber shall be coated with not less than 1.0 ounce of zinc per square foot of surface applied by the hot dip process.

When the plans specify tie rods for wing walls to be coated with waterproofing, the tie rods need not be zinc coated. Unless otherwise shown on the plans, all bolts shall have either square or hexagonal heads and nuts.

Washers shall be used under all bolt heads and nuts which would otherwise be in contact with wood. At the option of the Contractor, the washers may be either cast or malleable iron, but their diameter shall be at least  $3\frac{1}{2}$  times that of the bolt with which they are used. Washer head bolts and washer nuts of a design approved by the Engineer may be used in lieu of separate washers.

For fastening bracing and other members to piles, the Contractor shall furnish bolts with lengths which conform to the diameter, shape and positions of the piles so that extra washers or shims will not be required to take up excess lengths of bolts.

Nails shall be round or oval steel wire nails of standard quality. Machine bolts, drift pins or dowels may be either wrought iron or structural grade steel.



G. **Timber Connectors.** Metal connectors for resisting shearing stresses between tension members and for spreading the stress over the entire member shall be of a design approved by the Engineer. They shall be made of metal and shall be of sufficiently rugged type to withstand the handling and installation without damage.

**2408.03 STORAGE OF MATERIALS.** Lumber and timber when delivered to the site of the work shall be stored in neat piles. The ground underneath and in the vicinity of material piles shall be cleared of weeds and rubbish. Untreated lumber shall be open stacked on suitable skids at least 12 inches above ground and above possible high water. The piles of lumber shall be arranged to shed water and prevent warping, and when stored over a long period, shall be further protected by suitable covering.

Treated timber and treated piling shall be close stacked and piled. When stored for long periods, the tops of stacks and ends of pieces shall be covered to protect the material from the direct rays of the sun.

Miscellaneous material and hardware shall be stored in a manner which will prevent loss or damage to the same.

**2408.04 HOLES FOR BOLTS, DOWELS, RODS AND LAG SCREWS.** Holes for drift bolts and dowels shall be bored 1/16 inch smaller than the nominal diameter of the bolt or dowel used. Holes shall be bored to the proper depth so that they are fully occupied when the dowels are in place. Holes for rods and bolts other than drifts and dowels shall be bored to the same size as the nominal diameter of the bolt or rod used. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

Where the heads of bolts or lag screws would interfere with traffic or with other structural parts, they shall be counter-sunk.

**2408.05 TREATMENT OF CREOSOTED PILE HEADS.** After cutting, all surfaces of creosoted pile heads cut after the piles were treated shall be given two heavy brush coats of hot creosote oil followed by a thin coating of plastic asphalt cement specified in Paragraph 4120.02F.

For uncapped piles and piles with wood caps, the cutoff shall be covered with a sheet of asphalt roofing surfaced with powdered talc or mica not lighter than 55-pound grade, or with a sheet of copper or zinc weighing not less than 16 ounces per



square foot. This covering shall be neatly fitted and bent down around the sides of the pile 6 to 8 inches. The edges shall be neatly trimmed to a horizontal line and firmly fastened to the pile with galvanized roofing nails. The covering shall then be secured near its lower edge by at least three wraps of galvanized wire not smaller than 14 gauge.

For steel channel caps, after treatment with two brush coats of hot creosote, the entire surface which has been cut after the pile was treated shall be coated with a layer of plastic cement and after the cap is placed all joints between the cap and the pile shall be troweled full of plastic cement.

**2408.06 TREATMENT OF UNTREATED TIMBER.** When specified on the plans or Special Provisions the surfaces of untreated timbers and lumber shall be given the following treatment:

Two brush coats of hot creosote oil shall be applied to the ends, tops and all contact surfaces of sills, caps, floor beams and stringers; all ends, joints and contact surfaces of posts, bracing, and truss members; and all piling tops after cutoff. The back faces of bulk head plank and all other timber which is in contact with earth, metal or other timber shall be similarly treated.

The ends and tops of all caps, floor beams, and stringers after the brush coats of creosote have been absorbed shall be given a coat of plastic cement approximately  $\frac{1}{8}$  inch thick. The plastic cement which is squeezed out from between contact surfaces shall be struck off neatly with a trowel.

**2408.07 WORKMANSHIP.** All workmanship shall be first-class throughout. 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 wood surface. Deep hammer marks in wood surfaces shall be considered as evidence of poor workmanship.

Treated timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the treated surface with tools such as cant hooks, peaveys, timber tongs or pike poles.

**2408.08 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.



**2408.16 CONCRETE.** Any concrete required in connection with timber structures shall conform to the requirements of Section 2403.

**2408.17 METHOD OF MEASUREMENT.** The quantity of each of the various classes of timber will be computed by the Engineer in thousands of board feet from the nominal width and thickness and the actual length of material entering into the finished work. The Engineer will also compute the quantities of various other items included in the contract in accordance with the methods provided for the respective construction or material.

The weight of structural steel shall include the net weights of rolled shapes or plates, of rods used as tension members, and of all bolts and rivets used to fasten steel parts together.

The weight of drift bolts, dowels, washers, bolts and other hardware used to fasten wood parts together or to steel members will not be included in the weight of structural steel but such items shall be included in the weight of miscellaneous hardware, and shall be so computed by the Engineer.

Spikes and nails will not be measured separately for payment but shall be considered as incidental to the timber construction.

**2408.18 BASIS OF PAYMENT.** Timber structures shall be paid for at the contract unit prices for Excavation for structures, Piling, Untreated Timber Class A or Class C, Treated Timber, Concrete Masonry, Steel Reinforcement, Structural Steel and Miscellaneous Hardware, as specified in the contract. These unit prices shall be full payment for furnishing all materials, equipment and labor and the performance of all incidental work necessary to complete the work in conformance with the plans and these specifications.

### Section 2409. Plank Floors

**2409.01 GENERAL.** This construction shall consist of furnishing and installing either treated or untreated single or double plank floors in accordance with the detailed plans and the following provisions:

**2409.02 MATERIALS.** All materials used in the construction of plank bridge floors shall conform to the requirements



of the plans or the Special Provisions and to the requirements of Part IV for the respective materials as listed below:

Untreated lumber .....	Section 4138
Treated lumber .....	Section 4139

Floor clips shall be of a design approved by the Engineer. They shall be steel plates not less than  $\frac{1}{8}$  inch thick, coated after shearing and punching, with not less than 1.0 ounce of zinc per square foot of surface. Other hardware and nails shall conform to the requirements of Paragraph 2408.02-F.

**2409.03 CONSTRUCTION.** All floor plank shall be laid with the heart side down. Rough plank shall be laid with not more than  $\frac{1}{4}$  inch opening between the plank. Adjacent plank laid in the floor shall not vary more than  $\frac{1}{4}$  inch in thickness. Surfaced plank shall fit tightly together and present a smooth, uniform surface without variation due to difference in thickness or surfacing of the plank.

When the design requires wood stringers or nailing strips on steel beams each plank shall be securely spiked to each nailing strip or joist with not less than two wire spikes. The length of spikes used shall be 3 inches greater than the nominal thickness of the plank.

All shims and scupper blocks shall be fastened securely to the plank floor. The ends of the plank shall be cut to a true line parallel to the center line of the roadway.

When specified in the plans, the floor may be attached to the steel stringers or joists by steel clips. The clips shall be securely held between the plank by double pointed nails or by hooks or fins on the clips which engage both adjacent planks.

**A. Single Plank Floors.** Single plank floors shall consist of a single layer of wood plank of the size and type specified.

When the plank floor is to be covered with asphalt plank wearing surface the floor plank shall be surfaced on at least one side and one edge. Timber for plank floors which are installed as subfloors for asphalt plank wearing surface, or for double plank floors, shall be given full pressure preservative treatment as specified in Section 4137, unless otherwise indicated on the plans.

**B. Double Plank Floors.** Double plank floors when specified on the plans shall consist of two layers of plank supported by stringers or joists. The lower course of plank shall be laid parallel to the abutments of the bridge and the top course parallel to the center line of



the roadway. The plank shall be laid in the manner specified above. The top course of plank shall be fastened to the lower course by two spikes placed in pairs at intervals of not more than 4 feet. The length of spikes used shall be 3 inches greater than the nominal thickness of the plank. At the ends of the bridge the planks shall be beveled in such a manner as to provide a smooth riding surface.

**2409.04 METHOD OF MEASUREMENT.** The quantity of lumber used in plank floors shall be computed by the Engineer in thousand board feet as provided in Article 2408.17. Nails and other hardware will be considered incidental to the type of construction and will not be measured separately for payment.

**2409.05 BASIS OF PAYMENT.** Plank bridge floors built in accordance with the detailed plans will be paid for at the contract unit prices per thousand board feet for the types and grades of lumber specified in the contract. These prices shall be full payment for furnishing all lumber, nails, miscellaneous hardware and other materials, and the performance of all incidental work necessary to complete the structure in accordance with the plans and these specifications.

## Section 2410. Laminated Wood Floors

**2410.01 DESCRIPTION.** This construction shall consist of furnishing and installing either treated or untreated laminated floors in accordance with the detailed plans and the following provisions:

### **2410.02 MATERIALS.**

- A. **Lumber.** The floor strips shall be of the nominal dimensions shown on the plans, surfaced 4 sides. All strips for treated or untreated floors shall be of Douglas fir or Southern Pine, conforming to the requirements for Class C lumber, Section 4138.
- B. **Hardware.** All hardware shall conform to the requirements of Paragraph 2408.02-F except that nails used in treated material shall be coated with not less than 1.0 ounce of zinc per square foot of surface. Floor clips shall be  $\frac{1}{8}$  inch steel plates of a design approved by the Engineer, and coated, after shearing and punching.



with not less than 1.0 ounce of zinc per square foot of surface.

**2410.03 CONSTRUCTION.** The floor strips shall be placed on edge and securely nailed to preceding strips with at least one nail in each space between stringers or joists. The length of these nails shall be not less than  $2\frac{1}{2}$  times the nominal thickness of the strips. For floors with wood stringers or with nailing strips on steel beams each floor strip shall be toe-nailed to each stringer or nailing strip with 20d nails.

When so provided on the plans, laminated floors may be attached directly to steel beams by means of clips. Each clip shall be securely nailed to the floor strips with not less than two 20d nails. Care shall be taken in installing clips to insure that the floor strip is held firmly in contact with the steel beam.

Successive strips shall be so placed and fastened as to bear firmly on all supports and to be in close contact with the preceding strip. The space between any two adjacent strips shall not exceed  $\frac{1}{8}$  inch. The surface of the completed floor shall show no variation in elevation greater than  $\frac{1}{8}$  inch between adjacent strips.

The ends of the strips shall be cut in lines parallel to the center line of the roadway.

Floor drainage shall be provided by means of crown in the roadway surface.

**2410.04 METHOD OF MEASUREMENT.** The quantity of lumber used in laminated wood floors shall be computed by the Engineer in thousands of board feet from the nominal widths and thicknesses of the strips and the overall dimensions of the floor parallel to the length of the strips. Nails, clips and other hardware will be considered incidental to this type of construction and will not be measured separately for payment.

**2410.05 BASIS OF PAYMENT.** Laminated or strip floors built in accordance with the detailed plans will be paid for at the contract unit price per thousand board feet for Class C lumber. This price shall be full payment for furnishing all lumber, hardware and other material, and performance of all incidental work necessary to complete the structure in accordance with the detailed plans and these specifications.



## Section 2411. Concrete Floors

**2411.01 DESCRIPTION.** The construction herein specified shall include all concrete floors or concrete wearing surfaces on timber, concrete and steel bridges. The requirements of Sections 2403 and 2404 shall apply to this construction in addition to the following requirements:

**2411.02 CLASS OF CONCRETE.** The concrete used for all concrete floors and concrete wearing surfaces shall be Class A concrete as specified in Section 2403.

**2411.03 SWINGING THE SPAN AND SUPPORT OF FORMS.** Before the concrete is placed in the floor of a steel span, the centering of the span shall be struck and the span swung free on its permanent supports. Unless otherwise specified on the plans, forms for concrete floors and curbs shall be supported entirely by the steel which is to support the concrete.

**2411.04 PLACING REINFORCEMENT.** Steel bar reinforcement in floor slabs or resurfacing shall be wired rigidly at each intersection. Steel fabric reinforcement shall be of electrically welded rectangular mesh. Unless it is delivered in flat sheets, fabric reinforcement shall be straightened into flat sheets by passing it through adequate straightening rolls. All reinforcement shall be placed in the exact location specified on the plans.

Horizontal reinforcement shall be supported by means of an adequate number of metal supports as specified in Article 2404.06.

Concrete shall not be placed in a floor until the Engineer has inspected and approved the placing and fastening of the reinforcement.

Necessary splices of longitudinal reinforcement shall be made as nearly as possible to points where tension in the steel will be least.

**2411.05 PLACING CONCRETE.** The method of placement of floors on steel structures shall be varied with the relative stiffness of the structure to the end that deflections due to the load of the floor may not cause uncorrected distortions of the surface of the floor. Floors for relatively stiff, simple spans may be placed by an operation proceeding from one end of the span to the other. The method of placing floors on less rigid spans shall conform to that shown on the plans. The



concrete in floors shall be placed or finished with vibration as provided in Article 2403.11.

**2411.06 PLACING WEARING SURFACES.** Concrete wearing surfaces placed as a second course on concrete slab floors of steel or concrete bridges shall be placed continuously from one end of bridge. Expansion joints shall be furnished and installed to match existing expansion joints.

The portion of the expansion joint material which extends through the curb shall be double the thickness of the joint in the wearing surface. The thickness of expansion joint material in the resurfacing shall not be less than one and one-half times the thickness of expansion joint material in the original surface.

The old concrete floor shall be thoroughly cleaned of all dirt and loose or foreign material. All shattered or unsound concrete shall be completely removed. High spots which would reduce the final thickness of the resurfacing by more than 25 per cent of the designed thickness shall be removed. The floor shall be kept wet for at least one hour in advance of placing the concrete.

**2411.07 CURBS.** For floors which are poured as a monolith, the curb may be poured integrally with the floor slab. For spans on which the floor is cast in two or more sections to balance the dead load deflections, the curbs shall not be poured until the entire floor slab has been placed. Unless otherwise specified on the plans, curbs placed after the floor slab has set shall be doweled to the floor slab with  $\frac{1}{2}$ -inch steel dowels placed at not more than 24-inch centers.

**2411.08 JOINTS.** Expansion joints shall be constructed between spans, between the ends of the floor and back walls, and under the ends of each floor resting on an abutment. The location, type of filler and width of expansion joints shall be as shown on the plans. Vertical expansion joints in concrete floors shall be protected by steel plates of the type shown on the plans. The Contractor for the superstructure shall furnish and install all such plates and any required at the ends of a bridge to connect with existing pavements or structures.

**2411.09 DRAINAGE.** Transverse drainage shall be secured by means of crown in the roadway surface. Longitudinal drainage shall be secured by cast iron or welded steel drains placed in the concrete floor or curb in the locations shown on the



plans. All drains and their covers shall be furnished and installed by the Contractor for the superstructure.

**2411.10 SURFACE FINISH.** After the concrete is placed, it shall be struck off with a template to provide the proper crown. The top surface of all concrete floors, unless otherwise specified on the plans, shall be hand finished to a smooth, even surface as provided under Article 2301.21 for concrete pavement. For this purpose the Contractor shall provide equipment of the type specified under Article 2301.20.

**2411.11 CURING.** The concrete shall be kept damp for a period of four days as provided in Article 2403.12.

**2411.12 BASIS OF PAYMENT.** Concrete floors built in accordance with the detailed plans will be paid for at the contract unit prices for Concrete Masonry, Steel Reinforcement, Structural Steel, etc., as specified in the contract. These unit prices shall be full payment for furnishing all materials, equipment, labor, and performing all work necessary to complete the structure in conformance with the plans and these specifications.

No deduction will be made for the volume of concrete displaced by floor drains, expansion joints and metal strips for sealing joints. The cost of non-metallic expansion joint material and metal strips for sealing joints shall be included in the price per cubic yard for concrete masonry. The weight of structural steel paid for shall include all steel expansion plates, castings of steel or iron, or welded shapes for floor drains; bearing plates, anchor bolts and other steel parts except steel reinforcement for concrete and the metal fastenings therefor.

## Section 2412. Asphalt Plank Wearing Surface

**2412.01 DESCRIPTION.** This work shall consist of the construction of a pre-molded bituminous plank wearing surface on wood or concrete floors of bridges in accordance with the plans and the following provisions.

**2412.02 MATERIALS.** The materials used in the construction of asphalt plank wearing surfaces shall conform to the requirements for the respective materials as listed below:

Asphalt Plank ..... Article 4120.11

Asphalt for Sealing Cracks and for

Mop coat on Floors ..... Article 4120.05

85-100 Penetration



Nails used to fasten asphalt plank shall be 20d common wire nails coated with not less than 1.0 ounce of zinc per square foot of surface.

**2412.03 PREPARATION OF CONCRETE FLOOR.** Where an asphalt plank wearing surface is to be placed on a concrete floor, the concrete shall be cleaned of all dirt and other loose material. If necessary it shall be flushed with water and thoroughly brushed with stiff brooms. If the floor is not smooth and true to grade and cross section, a mortar cushion of Class C concrete as specified in Section 2403 shall be spread on the old concrete floor. This cushion shall be so spread as to provide a minimum thickness of one inch and shall be finished to produce a surface which when tested with a 10-foot straight-edge shows no variation greater than  $\frac{1}{8}$  inch. This mortar coat shall be cured with wet burlap as specified in Paragraph 2301.24-E and shall be allowed to harden for at least four days before the asphalt plank wearing surface is placed upon it.

The concrete or mortar surface shall be thoroughly dry before the mop coat is applied.

**2412.04 PREPARATION OF PLANK FLOORS.** When asphalt plank wearing surface is to be laid on plank floors, the floors shall be cleaned of all loose and foreign material. Floors shall be securely fastened to prevent vibration. All cracks greater than  $\frac{1}{4}$  inch shall be covered with metal battens. Variation in thickness of adjacent plank greater than  $\frac{1}{4}$  inch shall be corrected by replacing with new material.

**2412.05 HANDLING AND STORAGE.** Asphalt plank shall be handled and stored in such a manner as to avoid any breakage or deformation. In storage they shall be protected from the direct rays of the sun. A plank which becomes deformed or misshapen shall be rejected. A plank shall be considered deformed when either face departs more than  $\frac{1}{4}$  inch from a plane surface upon which it is placed.

**2412.06 LAYING ASPHALT PLANK.** Promptly after the floor has been prepared, the asphalt plank shall be laid as specified below.

The plank shall be laid with their long axes parallel to the center line of the roadway unless otherwise shown on the plans or specified in the Special Provisions.

Plank shall be forced tightly together by means of jacks or other devices so that the cracks between planks do not exceed



1/16 inch. The edges of the planks to which pressure is applied shall be protected from battering or breaking. The plank shall be kept in straight alignment and to an even surface. Plank with edges broken or split in nailing shall be replaced.

Asphalt plank shall be laid on wood or concrete floors as specified below:

- A. **Wood Floors.** On wood floors the asphalt plank shall be nailed at all corners and at intervals of not more than one foot on both edges. Nails shall not be placed farther than 2 inches from the edges of the plank. If the plank show any tendency to split in nailing, 3/16 inch holes shall be drilled and countersunk for all nails. Heads of nails shall be sunk flush with the surface of the plank, or when countersunk in close contact with the plank and not more than 1/8 inch below the surface.
- B. **Concrete Floors.** Asphalt heated to 275°F. to 325°F. shall be mopped evenly over the surface. Care shall be exercised in heating the asphalt to insure against overheating. The asphalt shall be applied in a thin, uniform layer without irregularities caused by the congealing of excess material. The asphalt plank shall be laid while the asphalt is still hot and plastic. The plank shall then be rolled with a heavy hand roller to force them into intimate contact with the coated concrete at all points.

**2412.07 FILLING CRACKS.** After the bituminous plank floor has been laid, all cracks shall be neatly sealed with asphalt heated to 275°F. to 325°F. Care shall be used that the asphalt is not overheated and not spread over the surface of the plank, but enough material is used to completely fill the crack. Suitable pouring cans with narrow spout and controlled orifice shall be used.

**2412.08 WEATHER CONDITIONS.** Whenever possible, this work shall be performed during warm weather with the temperature above 60°F. For work during weather when the temperature is below 60°F., the plank shall be thoroughly heated for at least two hours by immersion in tank of water maintained between 90° and 120°F.

**2412.09 METHOD OF MEASUREMENT.** The Engineer will compute the number of square yards of asphalt plank wearing surface from measurements of the completed work. The volume of Class C concrete used for cushion and level-



ing course will be computed in cubic yards by the Engineer from the number of batches used and the absolute volume entering into the average batch.

**2412.10 BASIS OF PAYMENT.** The quantities measured as provided above will be paid for at the contract unit prices. These prices shall be full payment for furnishing all material and equipment and for performing all work necessary to complete the surface in accordance with the plans and these specifications.

### Section 2413. Bituminous Mat Wearing Surfaces for Bridge Floors

**2413.01 DESCRIPTION.** This construction shall consist of the preparation of the bridge floor and application of a bituminous mat wearing surface in accordance with the plans and the following provisions for the type of wearing surface specified in the contract.

#### 2413.02 MATERIALS.

**A. Bituminous Materials.** The bituminous materials used shall comply with the requirements of Section 4106 for the following materials:

Tar Mat—Primer Tar (RT3) and Binder (RT9)	..4120.09
Asphalt Mat—Primer—Cutback Asphalt (RC-1)	..4120.06
Binder (Mixed Method) Cutback Asphalt (RC-3)	.....4120.06
Binder (Penetration Method) Cutback Asphalt (RC-4)	.....4120.06

**B. Aggregate.** Aggregate for use by the inverted penetration method shall conform to the requirements for  $\frac{1}{2}$  inch cover aggregate, Section 4111. Aggregates for mixed mats shall conform to the requirements of Section 4112,  $\frac{3}{8}$ " size.

**2413.03 WEATHER.** This work should preferably be performed in hot summer weather in order to facilitate the coating of the aggregate with bitumen. In cool weather the Engineer may require the heating of aggregates for penetration methods and of all materials for the mixed method in order to facilitate the coating of the material.

**2413.04 PREPARATION OF THE SUBFLOOR.** The subfloor shall be prepared in accordance with the following pro-



visions. The condition of the subfloor shall be inspected and approved by the Engineer before any bituminous material is applied.

A. **Wood Subfloor.** Before placing the carpet coat, all parts of the subfloor shall be securely fastened to prevent vibration, and all sharp corners, projections or irregularities in the surface shall be removed. Wood that is worn or contains defects which may be injurious to the bituminous carpet shall be removed and replaced with new material. Any openings in the floor shall be completely sealed with folded spelter coated metal battens or by calking with oakum. All dust, dirt, debris, or foreign material on or adhering to the surface to be treated shall be removed. If necessary, the floor shall be flushed with water and scrubbed clean. If water is used, the subfloor shall be allowed to become thoroughly dry and then shall be swept with stiff brooms before applying the first coat.

B. **Concrete Subfloor.** The requirements as to cleanliness specified above for wood subfloors shall also apply to concrete subfloors. Irregularities in the surface, such as might project into or injure the bituminous carpet shall be removed. Immediately before applying the first coat the surface shall be swept clean and no traffic permitted thereon until the carpet coat is placed.

**2413.05 HEATING AND APPLICATION OF BITUMINOUS MATERIAL.** All bituminous material will require heating to secure a sufficiently liquid condition for application. Care shall be used to insure that none of the material is overheated. The various materials shall be heated to temperature within the following limits:

Material	Grade	Temperature - °F.
Tar .....	RT-3	120-140
Tar .....	RT-9	200-225
Cutback Asphalt .....	RC-1	100-120
Cutback Asphalt .....	RC-3	150-200
Cutback Asphalt .....	RC-4	200-250

All bituminous material for primer, binder for inverted penetration method or for seal coats shall be applied by a pressure spray, preferably from a self-propelled distributor mounted on pneumatic tires, with spray bars for various width of strips to be applied. Whenever possible, the bituminous material



shall be applied to the full width of surface to be treated in one strip.

**2413.06 PRIMING COAT.** When the floor has been prepared in accordance with provisions of Article 2413.04 the priming coat shall be applied at the rate of 0.2 to 0.25 gallon per square yard. This coat shall be allowed to thoroughly set before any binder or wearing surface is placed thereon.

**2413.07 CONSTRUCTION OF MATS BY INVERTED PENETRATION METHOD.** Mats constructed by the inverted penetration method shall consist of a double application of bituminous binder with aggregate cover for each application, smoothed and rolled in accordance with the following provisions:

- A. **Application of Binder.** When the priming coat has thoroughly set, the bituminous binder shall be applied at a rate of 0.3 gallon per square yard. Unless otherwise ordered by the Engineer, the bitumen shall be applied to the full width of roadway before any aggregate cover is placed. Successive strips in which the bitumen is applied shall lap 6 inches to 1 foot. At the point of starting and stopping the application of bitumen at the ends of each strip, a width of paper shall be placed so that the spray may be started and stopped over the paper and dribbling or spraying beyond the intended limits will be avoided.
- B. **Spreading Aggregate.** Immediately after the bituminous binder has been applied, and while the bitumen is still plastic, the surface shall be uniformly covered with aggregate at a rate of 30 pounds per square yard. The aggregate shall be spread from a mechanical spreader which will deliver the aggregate to the treated surface in a uniform layer at the specified rate. In spreading the aggregate the wheels of the spreader and the transporting vehicle shall be kept off the fresh bitumen. At the time of spreading, the aggregate shall not contain more than 4.0 per cent of free moisture.
- C. **Rolling.** Immediately after the cover aggregate has been uniformly spread, the surface shall be rolled with a pneumatic tired or a steel surfaced roller weighing not less than 200 pounds per inch width of rolling surface. The entire surface shall be rolled at least four times. If the uniformity of the distribution of the aggre-



gate should be disturbed the aggregate shall be broomed during the rolling operation to restore the uniformity of distribution.

- D. **Second Coat.** When the first coat of cover aggregate has been spread and compacted the surface shall be given a second application of binder at the rate of 0.3 gallon per square yard, followed by a second application of cover aggregate applied at a rate of 30 pounds per square yard, applied and compacted as specified for the first coat.

**2413.08 CONSTRUCTION OF MATS BY THE MIXED METHOD.** After the application of the priming coat, the mixed wearing surfacing mixture shall be placed thereon in accordance with the following provisions:

- A. **Composition of Wearing Surface Mixture.** The wearing surface mixture shall conform to the requirements of Section 4202.
- B. **Spreading.** Before the spreading of the wearing course is begun, the quantity of mixture prepared shall be sufficient to cover the area to be treated. This mixture shall be spread and carefully raked to a uniform surface contour and to a loose thickness which will provide not less than the minimum compacted thickness shown on the plans. Care shall be used to maintain the uniform composition during the spreading. Any spots in which the mixture segregates shall be removed and replaced by fresh mixture of uniform composition.
- C. **Rolling.** After the mixture has been placed and raked to the desired surface it shall be allowed to aerate until the volatile portion of the bitumen has evaporated and the mix begins to stiffen. When the mixture has set sufficiently it shall be rolled with a roller complying with the requirements specified in Paragraph 2413.07C. Rolling shall begin at the edge and progress to the center line with each successive strip lapping the previous track by one-half the width of the rolls. The entire surface shall be covered at least twice in this manner. The surface shall be smooth and free from marks of the roller.

**2413.09 CONSTRUCTION OF ROCK ASPHALT SURFACE.** After the application of the priming coat, the rock asphalt surface shall be constructed thereon in accordance with the



following provisions. The rock asphalt shall be of uniform composition and any lumps which may have formed shall be broken up or discarded in the spreading. The rock asphalt shall be placed, raked to a smooth, uniform surface, and compacted as specified above for mixed mat construction.

**2413.10 SMOOTHNESS.** The completed surface shall show no deviation from the desired surface contour greater than  $\frac{1}{8}$  inch as indicated by a 10-foot straightedge. Bumps shall be removed and depressions filled with material which will bond thoroughly with the treated surface to bring the surface within the above specified variation.

**2413.11 PROTECTION.** During the application of bitumen and construction of this surfacing, the bridge structure, hand-rails and curbs shall be protected from spatter and disfigurement with bitumen.

**2413.12 OPENING TO TRAFFIC.** No traffic shall be permitted on surfaces being treated. Wheels of aggregate spreaders and trucks shall not run in the binder before the aggregate is spread. The surface may be opened to traffic as soon as the aggregate cover has been spread, smoothed and rolled, or after the mixed wearing course has been finally compacted.

**2413.13 BASIS OF PAYMENT.** Bituminous mat wearing surface will be paid for at the contract price per square yard for the type and thickness specified. This price shall be full payment for furnishing all materials and equipment necessary and performance of all work necessary to complete the surface in accordance with the plans and these specifications.

## Section 2414. Railings

**2414.01 DESCRIPTION.** The construction herein specified shall include all railings constructed on steel, concrete or timber bridges. All railings shall be constructed as shown on the plans. The requirements of Sections 2403, 2404, 2406, 2407, 2408, 2508, 2509 and the following provisions shall apply.

**2414.02 CONCRETE RAILINGS.** Concrete railings shall comply with the requirements for Class C concrete, Section 2403.

Forms for concrete railings cast in place shall be of first-class workmanship throughout. All mouldings, panel work



and beveled strips shall be straight and true, with neatly mitered joints. Forms may be made of metal or of surfaced wood. All areas which cannot be completely covered with one piece of wood shall be lined with metal, plywood or hard pressed waterproof composition board.

The top surface shall be float finished as specified in Paragraph 2403.26-A. The forms shall be removed in not less than 12, nor more than 48 hours and the entire surface of the rail given a rub finish as provided in Paragraph 2403.26-B.

Porous spots and places damaged by the removal of forms shall be repaired promptly after the removal of the forms and before the surface is finished. Expansion joints shall be constructed of the size and in the locations shown on the plans.

#### **2414.03 PIPE AND STRUCTURAL STEEL RAILINGS.**

Pipe railings shall be constructed of wrought iron or steel as indicated on the plans. Pipe shall conform to the requirements of Article 4134.06. Structural steel used in railings shall conform to the requirements of Section 4132.

Protection railings on abutments shall be furnished and installed by the Contractor for the substructure.

Metal for railings shall be painted in accordance with the provisions of Section 2508. The field coats of paint shall be furnished and applied by the Contractor for the superstructure.

**2414.04 WOOD RAILINGS.** Unless otherwise provided on the plans or in the Special Provisions, wood railings shall be constructed of Class C lumber. The details of the construction of wood railings shall conform to the requirements of Section 2408. Wood railings shall be painted in accordance with the provisions of Section 2509.

**2414.05 METHOD OF MEASUREMENT.** The volume of concrete in railings shall be determined as provided in Article 2403.27. The quantity of reinforcement in concrete railings shall be measured as provided in Article 2404.08. The weight of metal used in pipe railings shall be computed by the Engineer from the nominal weight of pipe and fittings used. Structural steel used in railings shall be measured as provided in Article 2407.38. The material used in wood railings shall be measured as provided in Article 2408.17.

**2414.06 BASIS OF PAYMENT.** Concrete railings will be paid for at the contract price for Class C Concrete Masonry



and Steel Reinforcement. Unless the contract provides a separate price for wrought iron and steel railings, such railings will be paid for at the contract price for Structural Steel. Wood railings will be paid for at the contract prices for Lumber and Hardware as provided in Section 2408. These prices shall be full payment for furnishing all materials and performing all work necessary to the completion of the railings in accordance with the plans and these specifications.

### Section 2415. Concrete Box, Arch and Circular Culverts

**2415.01 DESCRIPTION.** The provisions of this Article shall apply to all cast in place concrete culverts. The provisions of Sections 2401, 2402, 2403, 2404 and 2414 shall apply in addition to the provisions of this section.

**2415.02 FOOTINGS.** The footings shall be constructed to the elevations shown on the detailed plans unless otherwise directed by the Engineer. Footing depths may be increased when necessary to prevent undermining, scour, or to secure adequate bearing. In general, footing depth shall be decreased only when solid rock is encountered at elevations above those shown on the detailed plans. Suitable wood or metal forms shall be used to enclose all footing concrete.

**2415.03 CLASS OF CONCRETE.** Concrete shall conform to the requirements of Section 2403. All concrete, except in handrails, shall be of Class A concrete. The concrete in handrails shall be Class C concrete.

#### **2415.04 PLACING CONCRETE.**

A. **Footings.** Care shall be taken to prevent dirt, mud or other foreign material from becoming mixed with concrete which is being placed in the footing. The footings, pavements and curtain walls between construction joints shall be constructed as a monolith if practicable. A key notch of the form shown on the plans shall be provided between the walls and footings to insure proper anchorage. All dirt, dust, shavings or other foreign material shall be removed from the key notch and wall forms before placing the concrete.

B. **Barrels of Small Culverts.** For culverts 6 feet and less in height, the sidewalls and top slab shall be constructed as a monolith between construction joints. Construc-



tion joints shall be made by means of bulk-heads placed at right angles to the axis of the culvert.

C. **Barrels of Large Culverts.** For culverts more than 6 feet in height the concrete in the sidewalls may be placed and allowed to reach its initial set before constructing the top slab. The forming and reinforcement for the entire culvert shall be in place before any concrete is placed in the sidewalls or headwalls. Care shall be taken to insure adequate bond between the sidewalls and top slab.

D. **Headwalls.** In general, the headwalls shall be constructed as a monolith. However, when construction joints are unavoidable they shall be placed in a horizontal position and so located that no joint is visible above the roadbed. Sharp edges and corners shall be avoided by means of triangular fillet strips placed in the forms.

E. **Placing Concrete in Arch Culverts.** Concrete in arch culverts shall be placed in accordance with the provisions in Section 2508.

**2415.05 REMOVAL OF FORMS.** Forms for all culverts shall be removed as provided in Article 2403.23.

**2415.06 SURFACE FINISH.** All exposed parts of the wingwalls, headwalls and railings shall be surface finished in accordance with the requirements of Article 2403.26.

**2415.07 FILLING.** Backfilling shall be performed in accordance with the provisions of Article 2402.09.

**2415.08 PROTECTION RAILINGS.** Protection railings shown on the plans shall be furnished and installed by the Contractor. Protection railings shall be painted as provided in Section 2508.

**2415.09 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.** All concrete box, arch or circular culverts will be paid for at the contract unit prices for Excavation for Structures, Concrete Masonry, Steel Reinforcement, and other items included in the contract. Protection railing when specified on plans will be paid for at the contract unit price per pound for such railing material. These unit prices shall be full payment for furnishing all materials, equipment, labor and performance of all work necessary to complete the structures in conformance with the plans or as ordered by the Engineer.



**Section 2416. Rigid Pipe Culverts**

**2416.01 DESCRIPTION.** Rigid pipe culverts shall consist of the construction of culverts composed of concrete pipe, clay pipe or cast iron pipe as specified in the contract, and shall include both roadway culverts and private entrance culverts. Roadway culverts shall include all culverts placed on a public way whether primary road, secondary road, city street or other way maintained for public traffic. Private entrance culverts shall include all culverts for private drives such as entrances to farms, city lots, etc., which are not maintained for public traffic.

The installation shall conform to the detailed plans and the following requirements.

**2416.02 MATERIALS.** The pipe sections used shall conform to the requirements of Sections 4124, 4125 and 4126 for the type and class of pipe specified in the contract.

Concrete pipe shall be obtained only from plants whose equipment and operation have been approved under the provisions of Article 4124.01. Pipe of the 1500D class may be used as culverts for private entrances only. Pipe of the 2000D or 3000D classes will be used for roadway culverts, and will be used for private entrance culverts when the fill conditions require pipe of these classes.

**2416.03 PERMISSIBLE SIZE.** The maximum and minimum permissible sizes for rigid pipe culverts as determined by the nominal inside diameter shall be as follows:

	Minimum Size	Maximum Size
Roadway Culverts .....	18 inch	84 inch
Private Entrance Culverts.....	15 inch	84 inch

**2416.04 DEPTH OF FILL.** The fills over the tops of the various classes of pipe shall be within the following maximum and minimum limits for the respective classes of pipe and uses:

Class of Pipe	Depth of Fill Feet		
	Minimum		Maximum
	Road Way	Private Entrance	
1500D		1	15
2000D	2	1	20
3000D	2	1	30



**2416.05 INSTALLATION.** Except as otherwise indicated on the plans or in the Special Provisions rigid pipe culverts shall be installed in accordance with the following requirements:

- A. **Width of Trench.** The width of trench (if any) in which the pipe are placed shall be sufficient to permit thorough tamping of the bedding material under and around the pipes. In order to lighten the load which the pipe must carry, the width of trench shall not be greater than is required above except where absolutely necessary on account of field conditions such as the replacement of wider former construction.
- B. **Preparation of Base.** The surface upon which the pipe sections are to rest shall be brought to the desired grade which in general will be slightly cambered to correct for expected settlements and to insure tight joints in the lower half of the pipe. This surface shall be free from stones, roots or other inequalities in the bedding surface and where bed rock is encountered the trench shall be excavated below the bottom of the pipe for a depth at least equal to one-half inch per foot of height of fill over the pipe, but in no case less than one foot, so that all rock in this area is removed and the space filled with earth thoroughly tamped. The bedding surface shall provide a firm but slightly yielding foundation of uniform density throughout the length of the culvert. The surface upon which the pipe sections rest shall be trimmed to fit a template supported at the desired grade so that the pipe will be accurately bedded in firm material for a depth of at least one-tenth the overall height of the pipe. If, in the opinion of the Engineer, the material at the bottom of the excavation is of such nature as to cause unequal settlement, the trench shall be excavated below grade and backfilled with suitable earth or soil thoroughly tamped.
- C. **Placing Pipe Sections.** Proper facilities shall be provided for lowering the sections into place, without injury to the pipe. Each section shall be carefully bedded and placed in close contact with the adjacent section. The pipe section when placed shall be true to alignment and grade. In general the grade shall be slightly cambered to correct for expected settlement and to insure tight joints in the lower half of the pipe.



D. **Bedding and Backfilling Pipe Culverts.** Pipe culverts shall be bedded carefully in suitable material thoroughly tamped under and around the pipe for the full length and width of the culvert.

Earth shall be filled and thoroughly tamped around and over the culvert in accordance with the provisions of Sections 2402.08 and 2402.09 so that adjacent to the pipe on each side of the culvert there shall be a berm of thoroughly tamped or undisturbed earth at least as wide as the outside diameter of the culvert and extending to an elevation at least one foot above the top of the culvert. In addition to the backfilling required above, when so ordered by the Engineer, the Contractor shall build such approach fills as will provide a roadway 10 feet in width over the culvert with grades not steeper than 10%.

E. **Joints for Concrete Pipe.** Joints not exceeding  $\frac{1}{8}$  inch at the bottom,  $\frac{3}{8}$  inch at top and  $\frac{3}{8}$  inch at sides will be accepted without further treatment. Larger joints shall be fully encased with a reinforced concrete collar conforming to the requirements of type C-1 connection shown on Standard plan F-2. The concrete used shall be Class C concrete as specified in Section 2403. In addition to the collar, the inner surface of the joint shall be pointed full and flush with sand cement mortar for the lower three-fourths of the pipe perimeter.

**2416.06 METHOD OF MEASUREMENT.** The length of pipe installed shall be computed in feet from the laying length of the sections of the pipe used. Excavation for roadway culverts shall be measured as provided in Section 2402. Excavation for private entrance culverts shall be considered as incidental to this type of construction and will not be measured separately for payment.

**2416.07 BASIS OF PAYMENT.** The quantities of lineal feet of culvert pipe, excavation for installation of culverts and extra excavation for fills measured as provided above will be paid for at the unit contract prices. These unit prices shall be full payment for furnishing the pipe and all other materials, and for furnishing all labor and equipment and for the performance of all work necessary to complete the structures in conformance with the plans and these specifications.



## Section 2417. Corrugated Metal Pipe Culverts

**2417.01 DESCRIPTION.** Corrugated metal pipe culverts of the shop riveted type shall be constructed and installed in conformance with the detailed plans or as ordered by the Engineer and the following requirements. The definitions of roadway and entrance culverts shall be those included in Section 2416.

**2417.02 MATERIAL.** Corrugated metal culvert pipe shall conform to the requirements of Section 4121.

**2417.03 MAXIMUM AND MINIMUM SIZES.** For roadway culverts the minimum permissible diameter shall be 18 inches.

For private entrance culverts the minimum permissible diameter shall be 15 inches.

The maximum diameter for shop riveted corrugated metal culverts shall be 84 inches.

Culverts of total lengths greater than 38 feet shall be furnished in two or more sections of approximately equal length with no section having a length greater than 38 feet.

**2417.04 MINIMUM DEPTH OF FILL.** The minimum depth of fill over entrance culverts shall be one foot. The minimum depth over roadway culverts shall be as follows:

Diameter of Pipe (D)	Minimum Depth of Fill
24 inches and smaller.....	1 foot
30 inches to 42 inches.....	$\frac{1}{2}$ D
48 inches and larger.....	2 feet

**2417.05 INSTALLATION.** In all installations the trench for the lower 0.3 of the pipe diameter shall be carefully shaped to fit the curvature of the pipe and the backfilling to the top of the pipe shall be carefully placed and thoroughly tamped.

When pipe are installed in a projection condition the backfill shall be thoroughly tamped under the haunches of the pipe and on both sides to an elevation at least 1 foot over the top of the pipe. Except when pipe are installed as part of a grading contract the Contractor shall place the backfill in accordance with provisions of Paragraph 2416.05-D so that adjacent to the pipe on each side of the culvert there is a berm of undisturbed or thoroughly tamped earth at least as wide as the diameter of the pipe, for the full width of the embankment and extending at least one foot above the top of the pipe.



Pipe of the diameter four feet and larger under fills greater than 8 feet shall be stiffened by vertical posts placed inside the pipe to elongate it slightly in the vertical direction during the settlement of the fill. Timbers not smaller than 4 x 4 inches shall be placed for the full length of the culvert and the vertical posts wedged tightly against them. The posts shall remain in place until the fill is thoroughly consolidated.

**2417.06 METHOD OF MEASUREMENT.** The length of culvert specified shall be considered the length end to end of culvert when assembled. The length of culverts installed shall be measured by the Engineer. The average deficiency in length of any shipment of pipe shall not be greater than 1.0%.

Excavation for corrugated metal roadway culverts will be measured as specified in Section 2402.

Excavation for private entrance culverts will be considered as incidental to this type of construction and will not be measured separately for payment.

**2417.07 BASIS OF PAYMENT.** Unless otherwise provided in the special provisions all corrugated metal pipe roadway culverts of the shop riveted type will be paid for at the unit contract prices for the items of excavation for structures, extra excavation for fills and corrugated metal pipe culverts of the size specified in the contract.

For private entrance culverts, the excavation will be considered as incidental to the type of construction and included in the contract price for the pipe.

When the lengths of the individual culverts are specified in the proposal, the connecting bands required to form the complete culverts shall be furnished by the Contractor without additional cost. If the lengths of the individual culverts are not specified in the proposal, the connecting bands furnished shall be paid for as follows: For each 7-inch band, the contract price of 1 foot of culvert of the same size; for each 12-inch band, the contract price of 1½ feet of culvert of the same size; for each 24-inch band, the contract price for 2½ feet of culvert of the same size.

### Section 2418. Pipe Culverts Installed by Jacking

**2418.01 DESCRIPTION.** Installation of pipe culverts by jacking shall consist of furnishing and placing culvert pipe of the size, type and design shown on the plans, or specified in the contract in accordance with the provisions of this sec-



tion. This method of installation will be specified where maintenance of traffic on existing road requires that the traveled-way remain undisturbed, or where for other reasons, the installation of a culvert by the "cut and cover" method is impractical or undesirable.

This operation requires that the pipe culvert as a unit or in sections be forced through the existing embankment from side to side by the application of force to the projecting end, the necessary excavation being performed by the removal of the excavated material through the pipe as it progresses.

This method of installation may be required for culverts across either highways or railways when the latter are involved in a highway drainage improvement.

This method of installation will be required only when specified in the contract or ordered as "Extra Work."

**2418.02 TRAFFIC AND SAFETY.** On roads which must be kept open to traffic the operation shall be carried on without encroachment upon the traveled way by either the excavation or the storage of equipment or materials. Suitable warning signs and lights shall be furnished and maintained by the Contractor. When open cut excavation encroaches upon the shoulder the excavation shall be protected with substantial barricades.

On railways, the restrictions and safety regulations of the Railway Company shall be observed.

When open cut excavation is permitted on the slope of the embankment outside the vertical planes that bound the traveled way, adequate sheeting and bracing shall be provided if the nature and condition of the soil, or the height of the exposed faces is such as to endanger either the traveling public or the integrity of the road surfacing.

**2418.03 MATERIAL.** Pipe for culverts to be installed by jacking shall conform to the requirements of Sections 4121 and 4124 for the type specified on the plans or in the contract, and to the following requirements:

Pipe may be either in a single unit or sectional, but if sectional it shall have joints of a type that will assure positive engagement of the sections during the jacking process and subsequent thereto. Square end pipe without proper connecting devices will not be permitted.

Pipe having projections on their exterior surfaces such as to necessitate an excavation larger than the body of the pipe will not be permitted.



2418.04 CONSTRUCTION. Before jacking is started, the pipe or the initial section thereof shall be carefully aligned on a prolongation of the line and grade shown on the plans, or staked by the Engineer and shall be so held by braces, guide-ways and other devices as to deviate from these lines and grades as little as possible as it progresses through the embankment.

The number and capacity of jacks used shall be such as to exert sufficient force to overcome the greatest resistance to be encountered considering both the weight of the pipe and the friction on its exterior surface.

Care shall be taken that the jacks and struts are so arranged against the back slope, or deadmen placed for the purpose, that the thrust is applied parallel with the centerline of the pipe and distributed equally between the jacks.

The pressure exerted by the jacks shall be applied uniformly over the end of the pipe by a collar, or shall be distributed to a number of points around the perimeter by cross timbers. Application of pressure with the metal of the jack in direct contact with the material of the pipe will not be permitted with either concrete or corrugated metal pipe. Suitable cushioning material shall be inserted between the jack and the pipe. Spalled concrete or crumpled metal which will result in an unsatisfactory joint when the succeeding section of pipe is placed shall be cause for the rejection and removal of the section so injured.

Excavation for a limited distance ahead of the forward end of the pipe will be permitted when the soil is sufficiently stable to stand without danger of caving. In this case the hole shall be trimmed to the neat size of the outside of the pipe to reduce the resistance to jacking and maintain contact between the embankment material and the outside surface of the pipe. In the case of soft or unstable soil, the pipe shall be allowed to cut its own way through the soil to avoid danger of caving and subsidence of the overlying embankment and roadway. If the pipe is of metal with a coating of corrosion-resisting material, care shall be taken to protect this coating from injury during the jacking and excavating processes.

Obstructions to the progress of the pipe such as roots, boulders, or parts of former structures shall be removed and deviations from line or grade to pass such obstructions shall be avoided if such deviations will result in ill-fitting joints.



The use of explosives for removing such obstructions is prohibited.

Provisions shall be made for keeping the excavation free from surface and seepage water during the jacking operation.

After the excavation is opened the placing and jacking of the pipe shall follow immediately, and be prosecuted diligently to avoid unnecessary danger of disturbing the stability of the embankment and road bed.

Back-filling that may be necessary shall be done in accordance with the provisions of Article 2402.09. Surplus excavated material shall be disposed of in the immediate vicinity of the work as directed by the Engineer.

**2418.05 ACCURACY OF PLACEMENT.** When the location and grade line of the culvert have been determined by the position or elevation of the available outlet, the insertion of the pipe shall be from the outlet end.

When the location and grade line have been determined by the position of the inlet and the elevation to which the water must be lowered at the upstream end, the insertion of the pipe shall be from the inlet end.

In either case, the deviation from the designed invert elevation and location at the initial point shall not exceed 0.1 foot.

The alignment and elevation of the forward end of the pipe shall be kept under control throughout its passage through the embankment. Accumulated errors which cause the forward end of the pipe to deviate from the intended elevation or location by more than one-fourth the internal diameter of the pipe shall be cause for rejection.

Deviation from the prescribed lines that reverse the fall of the grade line through the culvert shall be cause for rejection.

Openings more than  $\frac{1}{4}$  inch in width between adjacent sections of concrete pipe shall be filled with 1 to 2 cement mortar.

**2418.06 METHOD OF MEASUREMENT.** The length of culvert specified shall be considered as the length end to end of the culvert when assembled. The length of culvert installed shall be measured in feet by the Engineer. The quantity of excavation to be paid for shall be the actual displacement of the pipe as calculated by the Engineer.

Roots, rocks, and other obstructions will not be measured or paid for separately, but shall be considered as incidental to the excavation and included therewith.



**2418.07 BASIS OF PAYMENT.** The contractor unit prices per lineal foot of culvert and per cubic yard of excavation measured as provided above shall be full payment for furnishing materials and equipment and for installing the pipe and for performing all the work incidental thereto.

### Section 2419. Laminated Wood Culverts

**2419.01 DESCRIPTION.** This construction shall consist of the fabrication and installation of culverts constructed of wood either built in place or from fabricated sectional units.

Laminated wood culverts shall be built in accordance with designs approved by the Commission. Typical plans for each size of culvert to be built, including wing walls, head walls, and other appurtenances to be furnished shall be filed with the Commission for approval. Such plans shall show clearly, for each size of culvert, the actual dimensions of the pieces of lumber composing the culvert. If culverts are to be fabricated in sectional units the size and arrangement of units in the completed culvert shall also be shown on the plans.

All culverts shall be provided with wing walls and head walls of approved design. The wings may be straight extensions of the walls of the barrel.

**2419.02 MATERIALS.** The materials used in laminated wood culverts shall conform to the following requirements:

- A. **Lumber.** The lumber from which laminated wood culverts are made shall be either Southern Pine or Douglas Fir conforming to the requirements of the A. S. T. M. Specifications for Structural Timber D245-37 for 1200# grade. All pieces shall be surfaced on four sides or on two sides and one edge to the required dimension for the specified size and grade of culvert. All framing and boring shall be done before treatment. The various pieces shall be so cut that there are no knots appearing in the bearing faces of the joint.
- B. **Treatment.** All lumber shall be given pressure preservative treatment as provided in Section 4137 without incising except that the final retention shall be not less than 10 pounds of water free preservative per cubic foot of wood.
- C. **Hardware.** Nails used in assembling culverts or fabricated sectional units shall be long enough to penetrate two thicknesses of material. Nails shall be steel wire



nails coated with spelter at a rate not less than 1.2 ounces per square foot of surface. The spelter coating shall withstand four one-minute immersions in the Preece Test. When bolts are used for assembling sections they shall be formed of rolled steel rods of structural grade of such length as to properly grip the laminae composing the sections. Heads and nuts of bolts shall be recessed into the lumber so that they do not interfere with placement of adjacent sections in construction of the culvert.

**2419.03 CONSTRUCTION DETAILS.** Laminated wood culverts may be constructed of sectional units which may be assembled in the field, or they may be constructed by building up the culverts in place.

The various laminae of the culvert shall be firmly attached to adjacent members or may be built into sections approximately four feet in length along the center line of the culvert. Sections may be made by nailing or bolting the laminae together. The size of nails or bolts and their location shall be as shown on the approved plans.

**A. Fabrication of Laminated Units.** When culverts are to be built of sectional units and assembled in the field these units shall be of two patterns, one of which will form the bottom and top of the culvert, and the other the sides. The full-length units shall cover 4 feet of culvert and half-length section 2 feet of culvert. Only a single-half length section may be used in either bottom or top and this shall be located at the end. Sections shall be so constructed that sections of bottom and top will lap half width with all side sections. The sections shall be so fabricated that they may be assembled easily and all joints will be smooth and tight and all pieces composing the unit will have proper bearing on the adjoining sections.

**B. Depth of Fill.** Standard culverts shall be installed under 2 foot minimum fills and 8 foot maximum fills. Where it is necessary to install culverts under fills with a minimum of one foot but less than two feet over the barrel of the culvert, extra strength top members shall be provided for the entire top of the culvert. Culverts for fills greater than 8 feet or less than 1 foot shall be of special design.



C. **Size of Culverts.** Standard laminated culverts will be built in the following sizes:

Clear Spans	3 ft.	4 ft.	5 ft.	6 ft.
Clear Heights	3 ft.	4 ft.	5 ft.	6 ft.

Culverts of other sizes or multiple openings will be considered as special designs.

D. **Marking.** All delivered units shall be plainly marked by stamping or burning into the wood a brand showing the following:

	Top and Bottom Sections	Side Sections
Standard Section	T & B Span — Ft.	Side Height — Ft.
Extra Strength Top	Ex. St. T. Span — Ft.	

E. **Installation.** The earth upon which wood culverts are installed shall be carefully shaped to smooth grade for the full length of culvert. All culverts shall be assembled in accordance with design approved by the Highway Commission. When the culverts are being fabricated in place, mud sills not smaller than 2 x 4 inches shall be laid flush with the bottom of the excavation for the full length of the culvert to insure the fabrication of the bottom in a true plane. When the culverts are built from fabricated sectional units the bottom full section shall be placed first. Side sections will then be placed to break joints with the top and bottom sections. All joints shall be forced into tight contact.

Sections shall be braced on the outside to maintain the rectangular cross section during the placement of the fill.

The top of each wing section shall be cut to the required slope and reinforced with not less than two strips of material extending from the head wall to the edge of the floor, covering the exposed ends of the lamination in the wings. The upstream and downstream edge of the floor shall be protected for the full width between wings by a row of tongue and grooved sheeting not less than 1½ inches thick, driven to at least 3 feet below the level of the floor.

When it is necessary to change the grade within the cul-



vert, the joint between sections at the grade change shall be made by accurately cutting each of the side sections adjacent to the joint on an angle with the lamination equal to half the change in grade. The edges of adjacent top and bottom sections shall be beveled to fit the change in grade and the joint in top and bottom sections shall be covered with a batten not less than 8 inches wide, whose upper surface is beveled to change in grade and which is firmly nailed to at least one of the sections. The sides shall be covered by nailing on the outside of the culvert, material not less than  $1\frac{1}{2}$  inches in thickness completely covering the joint. At least  $\frac{3}{4}$  of the pieces reinforcing each side of this joint shall be long enough to extend 6 inches over, and be firmly nailed to the second side section on each side of the joint. If joints of this type, in the opinion of the Engineer, are not cut with sufficient accuracy he may require that in addition to the reinforcement on the outside, the joint in walls and bottom shall be calked with oakum and covered with spelter coated culvert sheet metal not lighter than 16 gauge, meeting requirements of Section 4121. This metal covering shall extend at least six inches on each side of the joint. The sheets shall be smoothly nailed on each side of the joint with 10d nails at not more than 3 inch intervals. All surfaces of creosoted lumber cut after treatment shall be given two brush coats of hot creosote oil before being placed in the structure.

**2419.04 BACKFILLING.** The culverts shall be backfilled in accordance with provisions of Article 2402.09 and the following: Backfill shall be placed and tamped in layers not exceeding 6 inches after compaction. Layers shall be placed uniformly of equal height on both sides of the culvert and each layer thoroughly tamped before the next layer is placed. During the placing of the backfill each unit of the culverts shall be carefully braced on the outside to maintain their rectangular cross section. This bracing shall be left in place and the backfill carefully placed and tamped to cover the bracing and the culvert. For culverts installed in ditch conditions the backfill shall be tamped to a depth one foot above the top of the culvert.

**2419.05 METHOD OF MEASUREMENT.** The length of culvert specified shall mean the length of culvert barrel from



outside to outside of head walls. The Engineer will measure the completed culvert along the centerline of the top.

**2419.06 BASIS OF PAYMENT.** All laminated wood culverts measured as specified above shall be paid for at the contract price per lineal foot for the size and type of culvert specified in the contract, except that when stipulated in the Special Provisions contracts may be let on the basis of the lineal foot of culvert for furnishing the material only. These prices shall be full payment for furnishing all material, tools and labor required for completion of the culvert in accordance with the plans and these specifications.

### Section 2420. Sectional Plate Pipe and Arches

**2420.01 DESCRIPTION.** Sectional plate corrugated metal culverts shall consist of pipe or arches of the dimensions specified, fabricated of corrugated metal plates and installed in the location specified, in conformity with the lines and grades designated and with the following requirements:

**2420.02 MATERIALS.** The materials used in sectional plate corrugated metal culverts shall conform to the requirements of Section 4123.

**2420.03 SECTIONAL PLATES.** The plates shall consist of structural units of galvanized corrugated metal. Standard plates shall have a covering width of not less than 47 inches, measured along the neutral axis of the plate. The plates shall be of such lengths as to break joints as specified and provide the length of culvert specified.

The gage of plates for the various sizes of pipe and arches shall not be less than that specified on the plans in accordance with Division III, Sections 10 and 11 of the A. A. S. H. O. Standard Specifications for Highway Bridges (1944), for the type of installation involved.

Plates at longitudinal and circumferential seams shall be connected by bolts. Circumferential seams shall be staggered so that no circumferential seam shall be continuous for a greater distance than the width of the plate.

**2420.04 FABRICATION OF PLATES.** Each plate shall be curved to the proper radius and the bolt holes shall be so punched that all except the end plates shall be interchangeable in the erection process. As an alternate to this punching



the plates used in the two bottom segments of arches shall be punched with one row of bolt holes adjacent to the longitudinal edge of the plate which is to rest upon the pier or abutment.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart with one row in the crest and the other in the valley of the corrugations.

Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for bolt spacing of approximately 12 inches.

The center of no hole shall be closer to the edge of the plate than  $1\frac{3}{4}$  times the diameter of the bolt.

Bolt holes in plates 7 to 1 gage inclusive shall be punched before plates are galvanized.

When the completed structure is to be a full circle pipe, the plates shall be so curved that when bolted together true circles not smaller than the specified clear diameter shall be formed.

Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxides and burrs, shall present a workman-like finish and legible identification, and numerals shall be placed on each part of the plate to designate its proper position in the finished structure.

**2420.05 GAGE OF PLATES.** The gage of plates used in side and top plates of sectional plate pipe shall conform to the requirements of Division III, Section 10 of the A.A.S.H.O. Standard Specifications for Bridges (1944), for Strutted or Unstrutted pipe according to the method of installation to be used for the various fill heights. For pipe having gage lighter than 1 the bottom plates shall be the next gage heavier plate.

The gage of plates in arches shall not be less than that provided in Division III, Section 11 of the A. A. S. H. O. Standard Specifications for Bridges (1944).

**2420.06 BOLTS.** In either pipe or arches not less than 4 bolts shall be used per foot of longitudinal seam. In assembling the plates, bolts shall be so placed that the heads are in the valleys and the nuts are on the crests of the corrugations.

**2420.07 BEDDING OF PIPE STRUCTURES.** When a pipe structure is to be erected in a trench the width of trench must be sufficient to permit thorough tamping of the earth backfill against every plate except the bottom one. For multiple



structures the distance between adjacent sides shall be not less than  $\frac{1}{2}$  diameter with a maximum of 4 feet, to permit tamping the backfill against the sides of the pipe.

The pipe shall be bedded in an earth foundation of uniform density, carefully shaped by means of a template, supported at the desired grade and the required camber to fit the lower plate of the pipe. Where rock in either ledge or boulder formation is encountered it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe not less than  $\frac{1}{2}$  inch per foot height of fill over the pipe with a minimum thickness of 8 inches. Where firm foundation is not encountered at the grade established, due to soft, spongy or other unstable soil, unless other special construction methods are specified, all of such unstable soil for a distance of 1 diameter under and on each side of the pipe shall be removed and replaced with suitable earth or granular material properly compacted to provide adequate support of the pipe.

The bedding shall provide a minimum camber of 1% of the length of the pipe to take care of settlement after placing the fill. The amount of camber shall be varied to suit the height of fill and nature of supporting soil.

#### 2420.08 FIELD ERECTION, SECTIONAL PLATE PIPE.

Beginning at the downstream end, full sized bottom plates shall be placed along the centerline of the pipe, lapping each plate one corrugation on the previous plate. Plates shall next be placed on each side so that circumferential joints will be staggered at least 2 feet at each longitudinal joint and succeeding plates will lap inside the downstream plates in the same longitudinal row.

When plates in one circumferential row have been properly placed, all bolts in those plates shall be placed and tightened to draw plates into intimate contact. After all plates have placed all bolts shall be thoroughly tightened going over each section at least twice.

**2420.09 ARCH ANCHORAGE.** Each side of the arch shall be anchored to the foundation by means of a galvanized formed channel or a galvanized structural steel angle. The arch plates shall bear directly on the channel or angle. Channels shall be made of same material as the plates, shall be 7 gage, not less than 2-3/16 inches in depth with the shorter flange not less than 2 inches and the longer flange not less than 4 $\frac{1}{2}$  inches.



The web of the channel shall be bolted to the foundation at not more than 18 inch intervals.

If angles are used they shall be not lighter than 3 inches by 3 inches by  $\frac{1}{4}$  inch with not less than 3 ounce spelter per square foot. Angles shall be anchored to the foundation at not more than 24 inch intervals.

**2420.10 FIELD ERECTION, ARCHES.** Erection of the arch plates shall begin at the downstream end by bolting the side plates at intervals not greater than 18 inches to the angle or channel attached to the foundation. Plates shall be set inside the vertical leg of the angle or the longer leg of the channel and shall bear directly on the horizontal leg of the angle or the web of the channel. Succeeding plates shall be so assembled that joints at right angles to the centerline of the arch are not continuous for more than the width of one plate. The upper edge of each plate of the first ring shall be supported in its proper place until the full number of plates for the ring are in position. As soon as the plates in one ring are in position, all bolts in that ring shall be tightened to draw the plates into firm contact.

Bolts in each section shall be tightened at least twice to be assured that all are tight.

**2420.11 STRUTTING.** Unless otherwise specified, sectional plate pipes shall be timber strutted to increase the vertical diameter 3 per cent out of round before placement of the fill. The timber struts shall be in accordance with the Table A unless an elongation other than 3 per cent is specified.

The pipe shall be deformed the required amount by means of suitable jacks. The method of jacking shall meet with the approval of the engineer. A tolerance of  $\frac{1}{4}$  per cent above and below the specified amount will be permitted.

Strutting shall be carried uniformly from end to end of pipe for pipes without head walls. When head walls are used there shall be no elongation of the ends of the pipe. The struts shall be left in place until the fill is complete and compacted.

**2420.12 BACKFILLING SECTIONAL PLATE PIPE.** After the pipe has been assembled, fill material shall be deposited evenly on both sides of the pipe in layers not to exceed 6 inches before compaction, to a height equal to 1 foot above the top of the pipe, in accordance with the provisions of Article 2402.08 and 2402.09. Each layer shall be thoroughly tamped between the pipe and the sides of the trench or for a distance



LENGTH AND SPACING OF STRUTS FOR SECTIONAL PLATE PIPE

Height of Cover in Feet	Least End Dimension of Sill*, Cap* and Strut	Diameter of Pipe in Inches																	
		60		75		90		105		120		135		150		165		180	
		Length of Strut in Inches**																	
	4 in.	49 3/4	65 1/4	80 3/4	96 1/8	111 1/2	127	142 1/2	158										
	6 in.	43 3/4	59 1/4	74 3/4	90 1/8	105 1/2	121	136 1/2	152	167 1/2									
	8 in.		53 1/4	68 3/4	84 1/8	99 1/2	115	130 1/2	146	161 1/2									
		Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.	Size in in.	Spac-ing ft.
5		4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4	6.0	4x4	4.5	4x6	5.0	4x6	3.5	6x6	6.0
		4x4	6.0	4x4	6.0	4x4	6.0	4x4	5.0	4x4	3.5	4x6	3.5	6x6	6.0	6x6	6.0	6x6	5.0
10		4x4	6.0	4x4	6.0	4x4	6.0	4x6	6.0	4x6	5.0	6x6	6.0	6x6	6.0	6x6	6.0	6x8	6.0
		4x4	6.0	4x4	6.0	4x4	5.0	4x4	3.5	4x6	3.5	6x6	6.0	6x6	6.0	6x6	4.5	6x6	3.5
15		4x4	6.0	4x4	6.0	4x4	5.0	4x6	5.0	6x6	6.0	6x6	6.0	6x6	6.0	6x8	6.0	6x8	4.5
		4x4	6.0	4x4	5.5	4x4	3.5	4x6	4.0	6x6	6.0	6x6	6.0	6x6	5.0	6x6	3.5	6x8	3.5
20		4x4	6.0	4x6	6.0	4x6	6.0	6x6	6.0	6x6	6.0	6x8	6.0	6x8	6.0	6x8	5.0	8x8	6.0
		4x4	4.5	4x4	3.5	4x6	4.0	4x6	3.0	6x6	5.0	6x6	4.0	6x6	3.0	6x8	3.0	8x8	5.0
30		4x6	6.0	4x6	5.0	6x6	6.0	6x6	6.0	6x8	6.0	6x8	5.5	6x8	4.5	8x8	6.0	8x8	6.0
		4x4	3.5	4x4	3.0	4x6	3.0	6x6	4.5	6x6	3.5	6x6	3.0	6x8	3.0	8x8	4.5	8x8	4.0
40		4x6	5.0	4x6	4.0	6x6	5.5	6x8	6.0	6x8	5.0	6x8	4.0	8x8	5.0	8x8	4.5	8x8	4.0
		4x4	3.0	4x6	3.0	6x6	4.0	6x6	3.5	6x8	4.0	6x8	3.0	8x8	4.0	8x8	4.0	8x8	4.0
50		4x6	4.0	6x6	5.0	6x8	5.5	6x8	5.0	8x8	5.5	8x8	5.0	8x8	5.0	8x8	5.0	8x8	5.0
		4x6	3.5	6x6	4.0	6x6	3.5	6x8	4.0	6x8	3.0	8x8	4.0	8x8	4.0	8x8	4.0	8x8	4.0
60		6x6	5.5	6x8	5.5	6x8	4.5	8x8	5.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5
		6x6	4.5	6x6	3.5	6x8	4.0	6x8	3.0	8x8	4.0	8x8	3.5	8x8	3.5	8x8	3.5	8x8	3.5
70		6x8	6.0	6x8	5.0	8x8	5.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5
		6x6	4.0	6x8	4.0	6x8	3.5	8x8	4.0	8x8	3.5	8x8	3.5	8x8	3.5	8x8	3.5	8x8	3.5
80		6x8	5.0	8x8	5.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5	8x8	4.5
		6x6	3.0	6x8	3.5	6x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0
100		6x8	4.0	8x8	4.5	8x8	3.5	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0	8x8	3.0

\* Transverse cap and sill should be placed with least dimension vertical.

\*\* Length of struts based on 3% elongation of  $L = D + 3\%$ —3 times the least dimension of the strutting material. All timber dimensions are assumed as exact rather than nominal.



on each side of the pipe equal to the diameter of the pipe. After the fill over the pipe has been completed to the full height, the struts shall be released and removed.

#### 2420.13 BACKFILLING SECTIONAL PLATE ARCHES.

After the arch has been assembled the backfill shall be placed in accordance with the provisions of Articles 2402.08 and 2402.09.

**2420.14 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 shows defective workmanship, shall be rejected. The requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

- A. Uneven laps.
- B. Elliptical shaping (unless specified).
- C. Variations from a straight center line.
- D. Ragged edges.
- E. Loose, unevenly lined or spaced bolts.
- F. Illegible brand.
- G. Bruised, scaled, or broken spelter coating.
- H. Dents or bends in the metal itself.

**2420.15 METHOD OF MEASUREMENT.** The footage to be paid for shall be the actual number of linear feet of the pipe or arch, installed in place, completed and accepted. The measurement shall be as follows:

- A. Pipes and arches with either square or skewed vertical ends, end to end of metal, on center line of structure.
- B. Pipes with square ends, beveled, average end to end at top and bottom of pipe.
- C. Pipes with skewed ends, beveled, average end to end at top and bottom of pipe, parallel to center line.
- D. Arches, with ends other than vertical, as noted on the plans.

**2420.16 BASIS OF PAYMENT.** For the footage of sectional plate pipe or arches of the size specified, the Contractor will



be paid the contract price per foot. This unit price shall be full compensation for furnishing all materials, labor and equipment necessary to complete the work in accordance with the plans and specifications, except that paid for as excavation for structures, concrete masonry and steel reinforcement.



## DIVISION 25. INCIDENTAL CONSTRUCTION

This work shall consist of construction of various types in accordance with requirements of the sections listed below, incidental to the major types of construction of base courses, surface courses, pavements and structures.

- 2501. Piles and Pile Driving.
- 2502. Subdrains.
- 2503. Storm Sewers.
- 2504. Sanitary Sewers.
- 2505. Guard Rail.
- 2506. Flumes Incidental to Pavement.
- 2507. Concrete and Stone Revetment.
- 2508. Painting Steel Structures.
- 2509. Painting Woodwork.
- 2510. Waterproofing.
- 2511. Portland Cement Concrete Sidewalks.

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### Section 2501. Piles and Pile Driving

**2501.01 DESCRIPTION.** These requirements shall apply to the furnishing and placing of piles for foundations, for trestles, and for other exposed work.

**2501.02 MATERIALS.** The piles shall comply with the following requirements for the class of pile specified in the contract documents:

- Untreated Timber Piles, Article 4142.03.
- Treated Timber Foundation Piles, Article 4142.04.
- Treated Timber Trestle Piles, Article 4142.05.
- Precast Concrete Piles, Article 2501.03.
- Concrete Piles Cast in Place, Article 2501.04.
- Steel Piles, Section 4140.
- Concrete Sheet Piles, Article 2501.05.
- Steel Sheet Piles, Article 2501.06.

**2501.03 CONSTRUCTION OF PRECAST CONCRETE PILES.** Precast concrete piles shall be made of Class X concrete as specified in Section 2403, and be of the form and dimensions shown on the detailed plans, and shall be cast separately in conformity with the following requirements for construction and curing:



When individual platforms are used on which to cast single piles, the supporting foundations or false work shall be such as will prevent any settlement during the process of casting or curing the pile. When multiple platforms are used on which to cast more than one pile, special care shall be used to secure foundations adequate to support the entire number without deflection or deformation as successive piles are added. In either case, the bearing of the casting floors shall be subject to checking and approval by the Engineer. The forms used shall be built of surfaced lumber or metal true to line and mortar tight. They shall provide access for tamping and consolidation of the concrete.

The concrete in each pile shall be placed continuously and shall be carefully worked and consolidated around the reinforcement without displacing it. Special care shall be used to prevent the formation of stone pockets, honeycomb or other such defects.

The concrete shall be consolidated by small diameter internal vibrators or by other means approved by the Engineer. During this consolidation the excess concrete shall be screeded off and the surface smoothed to a texture similar to that produced by the forms.

The forms shall not be removed within 24 hours after the concrete is placed. The completed pile shall be straight and true to the form specified. All surfaces of the piles which will be exposed after driving shall be given the surface finish specified in Paragraph 2403.26-B. At his option, the Contractor may finish these surfaces after the forms are removed, or after the piles are placed in the structure.

A. **Protection and Curing.** The concrete piles shall be protected and cured as specified in Article 2403.12. The curing and protection period shall be extended until the concrete shall show a modulus of rupture of 600 pounds per square inch or more, when beams of the same concrete and cured in the same manner as the piles are tested as simple beams with 18 inch span loaded at the center.

In no case shall the piles be moved or strained in any other manner until they have been properly cured and aged ready for driving. In all moving or handling preparatory to driving, unless otherwise specified on the plans, the piles shall be supported at points one-fifth of the length of the pile from each end.



**2501.04 CONCRETE PILES CAST IN PLACE.** Concrete piles cast in place shall be constructed by driving steel shells of the specified length in the locations specified on the plans and filling the shells with concrete. The metal shell shall be of the type and dimensions specified on the plans. The method of driving shall be adapted to the type of shell used. The piles shall be constructed in accordance with the following additional requirements:

- A. **Inspection.** The contractor shall maintain on the work, at all times prior to the filling of the shells, a light suitable for the inspection of shells which have been driven. Any shells which have been improperly driven, broken, or are otherwise defective shall be removed and replaced or otherwise corrected.
- B. **Cutoff.** When the pile shells have been fully driven, inspected, and approved the shell shall be neatly cut on a horizontal plane at the elevation specified on the plans.
- C. **Filling.** After the shells have been cut off any water present in the shell shall be removed and after the steel reinforcement has been accurately placed the shell shall be completely filled with Class A concrete conforming to the requirements of Section 2403. At the time the concrete is placed the shell shall be free of accumulated water. In order to avoid the formation of air pockets the concrete shall be placed by vibratory methods as specified in Article 2403.11, or the concrete shall be placed in small charges of not over 2 cubic feet each.
- D. **Painting.** After metal shells have been filled with concrete they shall be painted with 3 coats of paint as prescribed for steel structures. The entire metal surface from the cap to low water elevation or 2 feet below finished ground line shall be painted in accordance with the provisions of Section 2508.

**2501.05 CONCRETE SHEET PILES.** Concrete sheet piles shall have the dimensions and reinforcement specified on the plans. Concrete sheet piles shall be made of Class X concrete conforming to the requirements of Section 2403. They shall be constructed and cured as provided for Precast Concrete Piles, Article 2501.03.

**2501.06 STEEL SHEET PILES.** Steel sheet piles that are to become a part of a finished structure shall be of the inter-



locking type with a web thickness not less than  $\frac{3}{8}$  inch, and a section modulus not less than that specified on the plans. The interlock shall be of a type approved by the Engineer. Used sheet piles shall be put in proper condition for redriving. Where steel sheet pile are to receive a concrete cap they shall be cut off neatly in straight lines at the required elevations after driving. The details at angles in sheet pile walls shall be adapted to the type of pile used and shall be subject to the approval of the Engineer.

**2501.07 DETERMINATION OF LENGTH OF PILES.** When the length of piles required is not specified definitely on the plans, unless test piles are required, the Engineer shall, within ten days from the date of contract award, determine the length of piles to be furnished by the Contractor. The length of piling ordered by the Engineer shall be in multiples of 2 feet for lengths 20 feet and less, and in multiples of 5 feet for lengths over 20 feet.

**2501.08 TEST PILES.** When the length of piles to be ordered cannot be determined satisfactorily by other means resort may be had to the driving of test piles and the determination of their load carrying capacity as provided in Article 2501.13. When so ordered by the Engineer, the contractor shall provide and drive test piles of the lengths and in the locations designated by the Engineer. Such test piles shall be driven with the same equipment as that which is to be used for driving the other piles for the structure. The contractor may be required to excavate to footing elevation in the area in which a test pile is to be driven before the test pile is driven.

**2501.09 EQUIPMENT FOR DRIVING PILES.** Either steam hammers or gravity hammers of suitable weight may be used for driving wood, concrete, steel H, or steel shell piles.

Equipment for driving piles shall conform to the following requirements:

A. Gravity Hammers. The fall of a gravity hammer shall not exceed the following:

Wood Piles .....	20 feet
Steel H Piles .....	20 feet
Steel shell Piles .....	15 feet
Concrete Piles .....	10 feet

To avoid the brooming or shattering of wood or concrete piles or the crimping or buckling of steel piles,



the Engineer may require the fall of the hammer to be reduced from the maximum limits given above.

The weight of gravity hammer used shall be such that when this weight is substituted for "W" in the formula for the gravity hammers in Article 2501.13 and the known values are substituted for "P," "H" and "M" in this formula, the computed value of "S" will not be less than one-quarter inch. In no case shall the weight of the hammer be less than 2000 pounds.

- B. **Single or Double-Acting Steam Hammers.** Single or double-acting steam hammers may be used for driving all kinds of piles provided the hammer used complies with the following limitations. When the weight of the ram and the energy per blow are substituted for "W" and "E" respectively in the formula for steam hammers in Article 2501.13 and the known values are substituted for "P," "H" and "M" in this formula, the computed value of "S" shall not be less than one-eighth inch.

The driving energy of double-acting steam hammers is dependent on the pressure and the rate at which steam is supplied to the cylinder. If this pressure is insufficient to develop the energy with which the hammer is designed to act, the Contractor will be required to increase the boiler capacity sufficiently to secure the desired results. Steam hammers shall not be operated at velocities higher than those recommended by the manufacturer of the hammer.

- C. **Water Jets.** When water jets are used the number of jets and the volume and pressure of the water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least 100 pounds per square inch pressure at two  $\frac{3}{4}$ " jet nozzles. Before the desired penetration is reached the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration. The jets shall not be attached to the pile, but shall be operated independently.
- D. **Followers.** The use of followers will not be permitted.
- E. **Driving Caps.** A driving cap shall be used to protect the heads of all wood and steel piles and all metal shells for cast in place concrete piles.



For wood piles this cap shall enclose the head of the pile to prevent brooming and splitting. For gravity hammers the lower recess of the driving cap shall be a truncated cone not less than 6 inches deep. The smaller diameter of this recess shall be 9 to 10 inches and the slope of the sides not less than one horizontal to 4 vertical. For steam hammers the depth of this enclosure shall be not less than 3 inches.

For steel piles and for steel shells for concrete piles cast in place the driving cap shall have a recess of the shape of the cross section of the pile or shell being driven.

#### 2501.10 PREPARATION OF WOOD PILES FOR DRIVING.

All wood piles shall be prepared for driving in accordance with the following provisions:

- A. **Preparation of Pile Heads.** The pile head shall be accurately trimmed to make a driving fit into the driving cap. In case the head of the pile becomes broomed or crushed before driving is completed the broomed fibers shall be trimmed off to provide sound wood accurately fitting the driving cap.
- B. **Preparation of Pile Points.** The lower end of the pile shall be cut square or tapered to a point not less than 4 inches square as directed by the Engineer. The tapered point, when used, shall be concentric with the centerline of the pile.
- C. **Metal Shoes.** When wood piles are to be driven to rock or through strata difficult to penetrate, the points shall be protected with metal shoes as shown on the plans or ordered by the Engineer.

#### 2501.11 PREPARATION OF PRECAST CONCRETE PILES

**FOR DRIVING.** The tops of all precast concrete piles shall be protected from injury from the impact of the hammer. This protection shall be so designed, maintained, and used as to cause the minimum absorption of energy consistent with adequate protection of the top of the pile. Where the plans require that the steel reinforcement of precast concrete piles extend beyond the end of the pile a suitable driving block shall be provided into which the reinforcement will extend without bending.



**2501.12 ACCURACY IN PLACING AND DRIVING PILES.**

In spotting the points of piles preparatory to driving, the Contractor shall use care to locate them as shown on the plans or as directed by the Engineer, and the deviation from such designated locations shall not exceed 3 inches at the time driving is begun except as may be made necessary by the presence of unavoidable obstructions. Only when shown on the plans or when specifically approved by the Engineer shall piling be driven closer together than 2 feet, 6 inches. While being driven piles shall be so held by toggles, shores or cables as to deviate the minimum possible amount from the vertical or the batter line shown on the plans.

**2501.13 DETERMINATION OF BEARING VALUE OF PILES.**

When so ordered by the Engineer the bearing value of piles shall be determined by actual load tests in which the entire load is applied concentric with the pile and careful measurements made with an engineer's level to determine the amount and rate of settlement. The test load shall not be applied until the pile has been allowed to rest at least 24 hours after driving. When bearing values are determined by test loads the pile shall sustain for 48 hours a load not less than 200 per cent of the load which the pile is designed to support with a settlement not greater than 0.25 inch.

When load tests are not specified in the contract documents or are not ordered by the Engineer or are impractical, the bearing value of piles shall be computed from the appropriate one of the following formulas:

**A. For Gravity Hammers**

$$P = \frac{3WH}{S+0.35} \times \frac{W}{W+M}$$

**B. For Steam Hammers**

$$P = \frac{3E}{S+0.1} \times \frac{W}{W+M}$$

Where  $P$  = the safe load in tons,

$W$  = the weight of a gravity hammer, or the ram of a steam hammer in tons,

$H$  = the height of free fall of the hammer or ram in feet.

$M$  = the weight of the pile plus the weight of the driving cap in tons.



$E$  = the energy per blow in foot tons (for single-acting steam hammers  $E = W \times H$ )

and  $S$  = the average penetration of the pile per blow for the last 5 blows for gravity hammers and last 10 blows for steam hammers.

The foregoing formulas shall be applied with compliance with the following conditions:

- (a) Unless the hammer has free fall the value substituted for "W" shall be less than the weight of the hammer by an amount sufficient to compensate for all friction and drag tending to retard its fall.
- (b) The head of the pile shall be free from broomed or crushed fibers.
- (c) The penetration of the pile is at a reasonably quick and uniform rate.
- (d) There is no excessive bounce to the hammer after the blow.
- (e) The value of "H" shall be less than the height of fall of the hammer by twice the height of the bounce.
- (f) When the driving has been interrupted for more than two hours, the pile shall be given at least ten blows before the determination of the bearing value is made.
- (g) For the computation of the bearing value for battered piles the value obtained from the formulas shall be multiplied by the following factor:

(Cosine  $a$ ) — (f sine  $a$ ). Where "a" equals the angle which the leads make with the vertical and "f" equals the co-efficient of friction between the hammer or ram and the surface on which it slides. For gravity hammers sliding on greased steel surfaced leads the value of "f" shall be assumed to be 0.1.

Bearing values of piles cast in place shall be determined by test loads or as provided by the special provisions applying to such work.

**2501.14 FOUNDATION PILES.** For the purpose of this article the term "foundation piles" shall be construed to mean all piles whether of wood, concrete or steel, which support superimposed loads and whose entire length in the completed structure, except that part which is contained in the footing, is driven into and supported laterally as well as vertically by surrounding soil.

Except as otherwise provided on the plans or in the special



provisions the excavation shall be completed before the driving of foundation piles is started. After the driving is completed, all loose and displaced materials forced up in driving shall be removed from around the piles leaving a clean solid surface to receive the footing concrete.

The arrangement of pile driving equipment for foundation work shall be such as to permit the leads to be lowered to the elevation of cutoff of the piling and the use of followers to transmit the blow to lower levels will not be permitted.

After piles have been driven to the required penetration the tops shall be cut to a horizontal plane at the required elevation. All crushed or broomed wood, battered metal or broken concrete shall be removed. The tops of treated wood piles shall be painted with 2 coats of hot creosote oil. Metal shells for cast in place concrete piles shall be inspected for their full length and approved before being cut off.

The heads of steel H piles shall be neatly trimmed and bearing plates firmly attached with at least one weld the full length of each flange of the pile.

Unless precast concrete piles have been cast with reinforcement exposed, the concrete of the pile shall be cut away to expose the reinforcement to provide a firm bond with the cap.

Unless otherwise provided on the plans or in the special provisions, all foundation piles shall be driven until the bearing value determined as provided in Article 2501.13 is at least equal to that specified in the following table for the class of piles being driven:

Wood Piles .....	20 Tons
Eight-inch Steel Piles .....	24 Tons
Ten-inch Steel Piles .....	32 Tons
Twelve-inch Steel Piles .....	40 Tons
Precast Concrete Piles .....	30 Tons
Concrete Piles Cast in Place .....	30 Tons

The length of piles shown on the plans or ordered by the Engineer for any specific structure shall be construed as indicating the desired penetration and the effort to secure this penetration shall be continued as long as the pile can be driven without injury to the pile.

In all cases, regardless of the fact that the required bearing value may have been secured, the driving shall continue until the following requirements as to penetration have been met:

- A. The minimum penetration in firm materials shall be ten feet, and in soft materials or materials which may be-



come soft when saturated with water, the minimum penetration shall be eighteen feet.

**2501.15 TRESTLE PILES.** For the purpose of this article the term "trestle piles" shall be construed to mean all piles whether of wood, steel or concrete which support superimposed loads but which in the completed structure will be exposed above the ground level for a part of their length. End bents of bridges and others around which fills may later be constructed are not thereby removed from this classification.

Wood and steel piles shall be driven with such accuracy as will permit them to be capped as shown on the plans with only such springing and bending as will not injure the pile. If, in the judgment of the Engineer, a pile has been seriously injured by springing after being driven it shall be removed and replaced.

Precast concrete piles shall be so driven as to stand without springing in the correct position and shall not approach closer than two inches to the faces of the caps as shown on the plans. In case it is necessary to move a concrete pile after driving to secure the above accuracy it shall be moved by loosening the soil surrounding the pile with jets until it can be moved and stand without strain in the correct position. After being moved the pile shall be driven a sufficient amount to assure the specified minimum bearing value.

Piles for trestles shall be cut off level or at the designed slope at the elevation of cut-off shown on the plans. The length of pile above this elevation shall be sufficient to permit the complete removal of all material injured by driving.

In creosoted wood piles, all bolt holes, cuts, daps or chamfers made subsequent to treatment as well as all abrasions of the surface and the tops of piles after cut-off shall be given two coats of hot creosote oil conforming to requirements of Article 4136.01. When the top of creosoted piles are not to be encased in concrete they shall be protected as specified in Article 2408.05.

Unless otherwise provided on the plans or in the special provisions all trestle piles shall be driven until the bearing value, determined as provided in Article 2501.13 is at least equal to that specified in Article 2501.14 for foundation piles. In all cases regardless of the fact that the required bearing value may have already been secured the driving shall continue until the following requirements as to penetration have been met.



- A. The penetration of precast concrete piles shall be as shown on the plans and only with the approval of the Engineer shall any deviation from this requirement be permitted.
- B. The length of wood and steel piles shown on the plans or ordered by the Engineer for any specific structure shall be construed as indicating the desired penetration and the effort to secure this penetration shall be continued as long as the pile can be driven without injury to the pile. Ordinarily the minimum penetration in firm material shall be ten feet and in soft materials or materials which may become soft when saturated with water, the minimum penetration shall be eighteen feet.

**2501.16 OTHER EXPOSED PILES.** Piles which do not carry superimposed vertical loads such as wing wall piles, fender piles, wing dam piles, and revetment piles, shall be driven to at least the penetration specified above for trestle piles or as shown on the plans or special provisions without regard to bearing values.

The heads of creosoted piles shall be treated after cutoff as specified in Article 2408.06.

**2501.17 EXTENSIONS AND SPLICES.** Every precaution shall be taken to avoid the necessity for extensions and splices of piles. When extensions or splices are necessary they shall be made in accordance with the following provisions:

After the driving of precast concrete piles is completed the concrete at the end of the pile shall be cut away to the extent that the reinforcement is exposed for a length not less than 40 diameters of the steel bars. 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 forms shall be placed. Care shall be taken to prevent leakage along the faces of the pile. The concrete used in the extension shall be of the same quality as that used in the pile. Just prior to the placing of concrete for the extension, the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement. The forms shall remain in place not less than 7 days after the concrete is placed in the extension, and shall be carefully removed. The entire surface of the piles to be exposed in the finished structure shall be finished to present a uniform color and texture throughout the length of the exposed surface.



Extensions of steel H piles and steel shells for cast in place concrete piles, after the removal of all battered metal, shall be neatly welded for the full exterior length of the joint. The axis of the extension shall coincide with the axis of the original pile.

**2501.18 METHOD OF MEASUREMENT.** The Engineer will measure to the nearest foot, the length of all piles placed in the leads for driving. For piles of all types except sheet piles and precast concrete bearing piles, the length measured for payment shall be the length placed in the leads minus one-half the length cut off during or at the completion of driving.

For precast concrete piles the length measured for payment shall be the length placed in the leads. Precast concrete blocks used to protect reinforcement extending beyond the end of the pile will not be considered a part of the pile.

For the length of precast concrete piles which is in excess of the length specified in the contract documents the volume of concrete required for such excess length will be measured in cubic yards and the additional reinforcement required for such extensions will be computed in pounds.

When the length of piles has been changed from that specified in the contract documents, by replacement with piles of greater length or by cutting piles to shorter length before driving, the Engineer will also measure the length of piles not driven.

The area of wall of sheet piles will be determined from measurements of the length of sheet piles driven and the horizontal center line length of the wall.

**2501.19 BASIS OF PAYMENT.** For all piles measured as provided above, the Contractor shall be paid the contract unit price which shall be full payment for furnishing, preparing, jetting, driving, and cutting of all classes of piles except as follows:

- A. **For Increased or Decreased Length of Piles.** Where timber, steel H, or steel shell piles ordered by the Engineer are of a length greater than that specified in the contract documents, the contract price per foot shall be increased by an amount sufficient to compensate the Contractor for the additional cost per foot of pile f.o.b the site of the work.

If the plans call for extra length of precast concrete piles as a protection during driving such extra length



shall be paid for as a part of the pile. In precast concrete piles which are extended after driving, for the extra length in the finished structure in excess of the length specified in the contract documents, the contractor will be paid the contract price per cubic yard for concrete masonry and the contract price per pound for steel reinforcement. No payment will be made for concrete used to replace portions of piles damaged in driving.

Where wood, steel H or steel shell piles are required to be spliced to obtain a length greater than that specified in the contract documents the cost of splicing wood piles or welding steel H or steel shell piles shall be paid for as extra work as provided in Paragraph 1109.04-B.

- B. **Piles Ordered and Not Driven.** Piles ordered by the Engineer or specified in the contract and not required in the construction shall be purchased by the County from the Contractor at the actual cost of piles delivered at the site of the work plus five per cent as an overhead charge. The piles so purchased become the property of the County. If piles ordered by the Engineer are required to be cut to shorter lengths before driving, payment shall be made as follows: The portion driven will be paid for at the contract price per lineal foot in the leads, except that for lengths cut back to lengths shorter than sixteen feet, payment will be made for the length ordered or sixteen feet, whichever is the less. Payment for that part of the length of piles cut off before driving shall be the actual cost of material delivered plus five per cent. The work of cutting off the piles shall be paid for as extra work. If piles have been pointed before being cut to shorter lengths the work of repointing the portions to be driven shall be included in the extra work.
- C. **Test Piles.** Unless the contract provides a unit price for this item test piles driven as ordered by the Engineer and under his supervision shall be considered as extra work and paid for as provided in Paragraph 1109.04-B.
- D. **Metal Shoes.** When the plans require that the points of piles be protected with metal shoes, such shoes shall be furnished without extra compensation. When such metal shoes are not specified on the plans they shall be furnished only upon order of the Engineer, in which case



they shall be paid for as extra work as provided in Paragraph 1109.04-B.

- E. **Sheet Piles.** When sheet piles are specified to become a part of the permanent structure they shall be paid for at the contract price per square foot for wood or concrete sheet piles of the thickness specified and for steel sheet piles of the specified weight and cross section for the area of the wall or walls placed. If no price for sheet piles is specified in the contract the payment shall be made as for extra work in accordance with the provisions of Paragraph 1109.04-B.

## Section 2502. Subdrains

**2502.01 DESCRIPTION.** Subdrains shall consist of pipe of the type specified on the plans with the intakes, intake gratings, blind inlets and outlet protecting walls and casings. The location and depth of subdrains, size of pipe and type of inlet and outlet protection shall be as shown on the plans. The construction shall comply with these specifications.

**2502.02 MATERIAL.** Drain tile shall comply with the requirements of Section 4127. Metal pipe for subdrains shall comply with the requirements of Section 4122.

**2502.03 BLIND INLETS TO SUBDRAINS.** Where indicated on the plans inlets to subdrains shall be constructed by filling the full width and depth of the trench for the length specified, with the material specified for porous backfill.

**2502.04 INTAKES.** Intakes shall be constructed in accordance with the design and the locations shown on the plans. The construction of intakes shall include placing the outlet pipe through the wall of the intake structure.

**2502.05 LAYING PIPE.** Construction of subdrains shall begin at the outlet and proceed continuously upgrade unless the Engineer grants permission to construct the drain in sections.

The Engineer shall furnish stakes and figures for the grade of the flow line and pipe shall be set accurately to line and grade.

The ends of drain tile shall be laid as close together as possible. If the space between adjoining tile exceeds  $\frac{1}{4}$  inch, this space shall be covered with carefully placed pieces of



broken tile. Junctions in lines of tile shall be made with special tile connections. Where a change in diameter of pipe is greater than 2 inches a special connection shall be used.

Joints in metal pipe shall be made with properly fitting connecting bands. Junctions of lines of metal pipe shall be made with properly designed fittings.

When existing tile lines are encountered, all necessary precautions shall be taken to prevent injury to same. Such tile lines shall be connected up with the drain being installed when such connections are ordered by the Engineer.

**2502.06 BACKFILLING.** No pipes which are in trenches six feet or less in depth shall be covered in any way until they have been inspected by the Engineer.

Where the depth of trench is more than six feet, unless a porous backfill is specified, the pipe may be covered by the last spading in the trench. In case the pipe is covered by the last spading in the trench the Contractor shall, at his own expense, uncover any pipe for inspection at the request of the Engineer.

Except when porous backfilling material is specified, the pipe shall be carefully covered to a depth of approximately six inches with soil or other approved material. Sand or boulders shall not be placed directly against the pipe. After the drain has been thus blinded the trench shall be entirely backfilled with all the materials excavated therefrom.

**2502.07 POROUS BACKFILL.** Where the installation of porous backfill is indicated on the plans the Contractor shall place material complying with the requirements of Article 4108.02 around and above the pipe to the depth shown on the plans. The remainder of the depth of trench shall be backfilled with earth taken from the trench. Any excess excavated material shall be disposed of as directed by the Engineer.

**2502.08 BACKFILLING TRENCHES ACROSS HIGHWAYS AND DRIVEWAYS.** Where the subdrains are placed beneath a highway or driveway, or within five feet of the edge of an existing or proposed pavement or base course, the backfilling material shall be placed in layers not over six inches in thickness, and each layer shall be carefully tamped.

**2502.09 METHOD OF MEASUREMENT.** The length of drain of the various types specified shall be measured in feet along the centerline of the drain.



Porous backfill material will be measured in cubic yards in the transporting vehicle at the point of delivery on the road except that the maximum quantity paid for shall not be greater than that necessary to fill a trench eighteen inches wide for trenches six feet and less in depth, or twenty-four inches wide for trenches over six feet in depth and to the depth specified.

**2502.10 BASIS OF PAYMENT.** The contract unit price per lineal foot for subdrain shall be full payment for furnishing all materials, tools and labor, including transportation necessary to complete the drain and place the backfill.

For subdrains built in accordance with the plans, no extra compensation will be allowed for over depth, rock excavation, tamping backfill or disposal of surplus material.

The contract price for porous backfill material, shall be full compensation for delivering the material to the site of the work.

The contract prices for intakes and for outlet protection walls shall be full compensation for furnishing all materials and labor necessary to the construction of these items.

### Section 2503. Storm Sewers

**2503.01 DESCRIPTION.** This work shall consist of constructing sewers for the removal of surface water from collection points adjacent to the road in accordance with the detailed plans and these specifications.

**2503.02 MATERIALS.** The material used shall conform to the requirements of Part IV for the respective items.

Pipe for storm sewers shall conform to the requirements of Article 4128.03.

**2503.03 CONSTRUCTION.** The construction of storm sewers shall conform to the following requirements:

- A. **Trench.** Trenches for storm sewers shall be of sufficient width to provide ample room for necessary joint treatment and for placing and tamping backfill material under and around the pipe. The final bedding surface on which the pipe rests shall be earth free from rock, stones, roots, or other inequalities, and shall be shaped so that the pipe rests in a concave saddle and bears uniformly on earth for not less than 25% of its circumference. If solid rock is encountered, excavation shall be carried 6



inches below the required elevation of the outside of the pipe, then backfilled with suitable material, well tamped and the bottom of the trench shaped as required for earth excavation.

For bell-end sewer pipe, bell holes shall be excavated ahead of the placement of the pipe.

**B. Laying and Placing Pipe.** Proper methods shall be used for handling and placing pipe to avoid spalling or breaking and to avoid unnecessary disturbance of bedding surface in trench bottom. Each pipe section shall be accurately placed to line and grade, and shall be carefully bedded and forced to a close end contact, with the adjacent section. For bell and spigot pipe, hand-crowded joints will be satisfactory. For tongue and grooved pipe, mechanical methods must be provided to force the bevel joints into intimate contact. Bell joints in sewer pipe shall be carefully filled with mortar, consisting of one part Portland cement and three parts sand (by volume) screened to pass an eight mesh sieve. Any mortar protruding inside the joint shall be removed and the lower two-thirds of the joint pointed full and flush. If joints are opened due to angles in alignment, such openings shall be covered with concrete collars. Collars shall be constructed of Class C concrete conforming to the requirements of Section 2403 and shall have the dimensions and reinforcement specified for Type C-1 connections on Standard Plan F-2.

**C. Backfill.** No backfill shall be placed until the line and grade of the pipe has been approved by the Engineer.

Backfilling shall be done in conformance with the provisions of Paragraph 2504.03-D.

**D. Catch Basin, Intakes and Manholes.** All catch basins, intakes and manholes shall be constructed in accordance with the detailed plans. These items shall include placing the necessary sections of pipe for inlet and outlet lines through the walls of the structure.

**2503.04 METHOD OF MEASUREMENT.** The length of storm sewer constructed shall be measured in feet, by the Engineer. Such measurement shall exclude the space across catch basins, intakes and manholes where the pipe is not actually placed.



**2503.05 BASIS OF PAYMENT.** The contract price per lineal foot for storm sewer construction shall be full payment for furnishing all materials, equipment, tools and labor, including excavation and the hauling necessary to lay the pipe and place the backfill in accordance with the plans and these specifications. It shall include the furnishing of sections of pipe for inlet and outlet lines through the walls of catch basins, intakes and manholes. No extra compensation will be allowed for over-depth, or rock excavation.

The contract price for constructing a catch basin, intake or manhole shall be full payment for furnishing all the material, labor, tools and equipment for completing such structures in accordance with the plans except for furnishing the pipe necessary for inlet and outlet connections which pipe shall be measured and paid for as storm sewer.

### Section 2504. Sanitary Sewers

**2504.01 DESCRIPTION.** This work shall consist of the consist of the construction of sanitary sewers together with the manholes, lampholes and other incidentals in accordance with the plans and these specifications. In addition to these specifications it shall be the Contractor's duty to comply with local ordinances and requirements that may apply to the work.

**2504.02 MATERIALS.** The materials used in sanitary sewers shall conform to the following requirements:

- A. Sewer Pipe .....Section 4128
- B. Brick .....Article 4129.03
- C. Concrete .....Class A Concrete, Section 2403
- D. Reinforcing Steel .....Section 4131
- E. Iron Castings .....Article 4134.04

Manhole covers located in traffic lanes shall weigh approximately 350 pounds, including ring and lid. They shall be provided with lid locking lugs. Covers for locations not subject to traffic, when so specified, may weigh approximately 145 lbs., including ring and lid. The inside diameter for either weight of casting shall be approximately 24 inches.

**F. Step Irons.** Step irons shall be  $\frac{3}{4}$  inch plain round bars bent in the form of a "U" 15 inches in width with 12 inch legs as shown on the plans.

**G. Gaskets.** Hemp or Oakum gaskets for pipe joints shall be closely twisted and shall be of suitable diameter,



but in no case less than  $\frac{3}{4}$  inch and shall meet the approval of the Engineer.

- H. Mortar. Mortar for pipe joints and for brick masonry of the manholes shall consist of one part Portland cement conforming with requirements of Section 4102 and two parts fine aggregate conforming with Section 4106, and sufficient water to produce proper consistency.

**2504.03 CONSTRUCTION.** The construction of sanitary sewers shall conform to the following details:

- A. Preparation of Trenches for Pipe Laying. Trenching shall be in open cut except with the written permission of the Engineer. Permission for tunnel work may be given for crossing under crosswalks and house drives or under service pipes when such tunnels will not exceed ten feet in length. The length of trench to be opened at one time may be limited when, in the opinion of the Engineer, such limitation is necessary.

Trenches shall be only of sufficient width to provide a free working space on each side of the pipe of not less than four inches nor more than one-third the nominal diameter of the pipe.

Trenches shall be kept free from water until the material in the joints has hardened.

Trenches shall be sheeted and braced as necessary. Such sheeting shall not be removed until backfilling has progressed to such a stage that no damage to pipe lines or structures will result from its removal.

- B. Preparation of Foundation for Pipe Laying. When the excavation is in firm earth, care shall be taken to avoid the removal of material below the suitable bearing depth.

If the foundation is in rock, the excavation shall be carried to an elevation which will provide for a bedding course not less than twelve inches thick below the body of the pipe. This bedding course shall be suitable earth or sand, free from rocks, roots, sod or vegetable matter and shall be firmly tamped in place before shaping the bed to fit the pipe.

Before pipes are placed the bottom of the trench shall be shaped to give full support to the lower one-fourth of the pipe circumference. Adequate bell holes shall be made at each joint.



C. **Pipe Laying.** The laying of pipes shall commence at the lowest point so that the spigot ends point in the direction of flow. All pipes shall be laid with ends abutting and true to line and grade. The grade and line of each pipe shall be checked with a top line and a measuring grade rod and a plumb bob. The pipes shall be fitted and matched so that when laid they will form a sewer with a smooth uniform invert.

Socketts shall be carefully cleaned before pipes are lowered into trenches. The pipes shall be so lowered as to avoid unnecessary handling in the trench.

Joints shall be made in the following manner: A closely twisted jute or oakum gasket in one piece of sufficient length to pass around the pipe and lap at the top, shall be solidly rammed into the annular space between the pipes with a suitable calking tool. Before being placed the gasket shall be saturated with neat cement grout. After the gasket has been rammed into place the remaining space in the joint shall be filled with mortar carefully crowded into place and beveled off on the outside.

For pipes less than eighteen inches in diameter a swab shall be pulled through the inside of the pipes as laid to wipe out all foreign matter and smooth any roughness at inside of joints caused by extruded mortar. For pipes eighteen inches and larger all joints shall be pointed and smoothed from the inside with joint mortar.

D. **Backfilling.** Before any backfill is placed the pipe line shall be checked with a light. Each unit shall show a good light circle throughout its length. No backfill shall be placed until the joints have hardened sufficiently to preclude the liability of displacement.

Backfill shall be suitable earth free from boulders, large roots or excessive sod or other vegetation. Backfill shall first be carefully hand-tamped under and around the pipe, up to six inches above the top of the pipe, in lifts not to exceed four inches loose thickness. Care shall be used to so place and tamp this bedding course as not to disturb the joints, alignment or grade of the pipe. Filling shall be carried on simultaneously on both sides of the pipes.

Where the pipe line is placed beneath a roadway or driveway, or within five feet of the edge of an existing or proposed pavement or base course, the tamping shall



continue in six inch lifts to the surface and such tamping shall be done with a mechanical tamper of an approved type.

Where the pipe line is clear of roadways or driveways to a distance of five feet or more, the hand-tamped backfill shall be placed, as specified, to six inches above the top of the pipe. At the Contractor's option the remainder of the trench backfill may be consolidated by flooding with water, or tamping in six inch layers. Any settlements which develop after flooding shall be filled up to surface.

- E. **Manholes.** Brick, mortar, and concrete used in manholes shall be of the quality specified. Unless other dimensions are specified, each manhole shall be built on a level concrete base six inches thick by five feet eight inches in diameter at such elevation that pipe sections built into the wall of the manhole will be true extensions of the lines of pipe.

Walls of the manhole shall be eight inches wide consisting of header courses, with brick laid to break joints. Mortar joints between courses shall not exceed  $\frac{1}{2}$  inch in thickness and vertical joints between brick shall not exceed  $\frac{1}{4}$  inch on the inside. All joints shall be shove joints completely filled with mortar. The inside diameter of the brickwork shall be four feet. At the top the courses may be drawn in at the rate of one inch per course to fit the cast iron cover ring.

That portion of the manhole which is tapered shall be plastered on the outside with mortar.

Step irons shall be placed in the brick work at the intervals specified, but not more than 18 inches.

Inside the brick work half-pipe shall be bedded in concrete for the flow line through the manhole with the concrete carried out to the brick work and sloping toward the top of the half-pipe. These half-pipe shall be accurately joined to the sections built into the walls of the manhole. Pipe sections to be installed in the manholes will be furnished by the Contractor for the lines of pipe.

Details for drop manholes, lampholes, or other special construction features will be shown on the plans.

**2504.04 CLEANING UP.** After the completion of the work the contractor shall thoroughly clean and smooth the disturbed area and remove all excess dirt and materials.



**2504.05 METHOD OF MEASUREMENT.** The Engineer will measure the number of lineal feet of each size of sanitary sewer laid. No deduction will be made from the lineal footage of pipe for the space occupied by manholes.

**2504.06 BASIS OF PAYMENT.** The contract price per lineal foot for the various sizes of sanitary sewer shall be full compensation for furnishing all materials, equipment, tools and labor, including disposal of surplus excavated material necessary to construct the sewer and place the backfill in accordance with the plans and these specifications. No extra compensation will be allowed for over-depth, rock excavation, or tamping backfill.

The contract prices for manholes and lampholes shall be full payment for furnishing all materials, labor, tools and equipment necessary to complete the same in accordance with the plans and these specifications, except the pipe sections in the manhole which will be included in the lines of pipe.

### Section 2505. Guard Rail

**2505.01 DESCRIPTION.** Guard rail shall consist of posts supporting cables, plates or beams erected on the shoulder line of a roadway including required end anchorage constructed in accordance with the plans.

**2505.02 MATERIAL.** The material used shall conform with the requirements of Part IV for the type and class of guard rail materials shown on the plans, unless otherwise specified, the posts shall be round pressure treated southern pine.

**2505.03 SETTING POSTS.** Posts shall be set firm and plumb and to the lines and grades given by the Engineer. The backfilling in the post holes shall be thoroughly tamped and end posts shall be braced as shown on the plans.

**2505.04 STRETCHING CABLE.** Cable shall be stretched taut by a satisfactory mechanical device. The length of cable shall be so adjusted that when the cable is taut the tightening nuts are at approximately the center of the threaded portion of the tightening rods, and spring take-ups are compressed by an amount sufficient to compensate for changes in temperature.

**2505.05 SETTING END ANCHORAGE.** End anchorages shall be set to the angles and depths shown on the plans. The excavation shall be backfilled in layers not more than six



inches loose thickness, and each layer shall be thoroughly tamped before the succeeding layer is placed. Anchor rods shall be fully threaded through nuts and turnbuckles before cables are tightened.

**2505.06 BORING, FRAMING AND DOMING TREATED WOOD POSTS.** All treated wood posts shall be domed and bored before the post is treated. If it becomes necessary to bore additional holes after the post is treated, such holes shall be treated with creosote oil by a pressure process approved by the Engineer.

**2505.07 PAINTING GUARD RAIL POSTS.** Guard rail posts shall be painted as indicated on the plans. The painting on the upper portion of wood posts that are not pressure treated with creosote, shall consist of two coats of white paint complying with the requirements of Paragraph 4135.04-A. The painting on the lower portion of all posts shall consist of two coats of black paint complying with the requirements of Paragraph 4135.04-I. The painting on the upper portion of wood posts pressure treated with creosote oil shall consist of two coats of aluminum paint complying with the requirements of Paragraph 4135.04-F. The paint shall be brushed thoroughly and all exposed surfaces shall be completely covered.

The provisions of Articles 2508.04 and 2508.05, and Section 2509 shall apply to the painting of guard rails.

**2505.08 METHOD OF MEASUREMENT.** The length of guard rail constructed, exclusive of end anchorages, shall be measured in feet.

**2505.09 BASIS OF PAYMENT.** The contract price per foot of guard rail shall be full payment for furnishing all materials and performing all labor required for constructing the guard rail as shown on the plans, exclusive of end anchorages. The contract price per end anchor shall be full payment for furnishing all material and performing all labor necessary for the construction of the end anchorage in accordance with the plans.



## Section 2506. Flumes Incidental to Pavements

**2506.01 DESCRIPTION.** Flumes for the removal of water from pavement shall consist of a shoulder basin, a slope drain, and a discharge basin, or a connection to a roadway culvert. It shall also include a guard post. Such flumes shall be constructed in accordance with the plans and the following requirements.

**2506.02 MATERIALS.** All materials used shall conform to the requirements of Part IV and the following:

- A. Sheet metal for slope drain shall be spelter coated sheets of the gauge specified on the plans, and conforming to the requirements for culvert sheets, Section 4121.
- B. **Angles.** Channels and other metal parts required for exposed use shall be structural steel conforming to the requirements of Section 4132, and shall be coated on all surfaces, except female threads, with not less than one ounce of zinc per square foot of surface.
- C. Steel Reinforcement shall be either plain or deformed bars of either Structural or Intermediate grade conforming to the requirements of Section 4131.
- D. Guard posts may be either untreated, treated, sawed or round wood posts conforming to the requirements of Section 4143. The size of post and painting shall conform to the requirements of the plans.

**2506.03 CONSTRUCTION.** The concrete used shall be proportioned and placed in accordance with the provisions of Section 2403, Concrete Masonry, Class A. In all cases, the earth on which the flume is to rest, and for an additional width of 3 feet on each side, shall be thoroughly compacted to an elevation not lower than the subgrade of the flume. After the flume has been constructed and the embankment completed, the guard post shall be set in the required location.

**2506.04 METHOD OF MEASUREMENT.** The number of lineal feet of concrete slope drain shall be measured along the flow line of the drain from the point designated on the plans as the upper end of the slope drain to the point where the gradient of the flow line of the drain breaks at its junction with the discharge basin. For metal slope drain the actual overall length of slope drain installed shall be measured along the flow line of the slope drain. No other parts of the flume shall be measured separately for payment.



**2506.05 BASIS OF PAYMENT.** For flumes incidental to pavement the contract price per flume shall be full payment for furnishing all materials and for performing all labor required for the construction of all parts of the structure, except the slope drain measured as indicated on the plans. The contract price per foot of slope drain shall be full payment for furnishing all materials and performing all labor required for the construction of such slope drain.

### Section 2507. Concrete and Stone Revetment

**2507.01 DESCRIPTION.** This revetment shall consist of the placement of a layer of stone or concrete for the protection of earth slopes against erosion by stream flow or wave action. This protective layer shall be placed in accordance with the plans and these specifications for the class of revetment specified in the contract.

**2507.02 MATERIAL.** Materials for revetment shall conform to the requirements for the various kinds of materials in Part IV.

**2507.03 CONSTRUCTION.** Revetment construction shall consist of three classes, as hereinafter specified. For all these classes of revetment, construction shall begin in a trench dug to the elevation shown on the plans. After the completion of the revetment, the trench shall be backfilled with materials excavated.

**A. Class A Revetment.** Class A revetment shall consist of a layer of the stone specified, over the specified area. This layer shall be so placed that each stone is firmly bedded against the bank, and in contact with adjacent stones. The stone need not be laid in courses, but spalls shall be driven into openings remaining after the layer of stone is placed. The thickness of this layer shall be approximately 15 inches, and no portion shall have a thickness less than 12 inches. Portions of individual rocks projecting more than 2 inches above the general contour of the surface shall be broken to within these limits.

**B. Class B Revetment.** Class B revetment shall consist of a layer of the stone specified for this class placed in definite horizontal courses over the specified area. Stone in successive courses shall be so placed as to break joints. Stones shall be placed in close, firm contact with each



other, and shall be firmly bedded against the bank. Spalls shall be driven into all openings between the stones. The layer shall not be less than 12 inches thick, and the finished surface shall present a reasonably smooth surface with no variation greater than 2 inches in any square yard. Stone shall be placed with their bedding planes parallel to the courses and perpendicular to the slope.

C. **Class C Revetment.** Class C revetment shall consist of concrete blocks cast in place over the area specified. The length, breadth, and thickness of the blocks and their reinforcement shall conform to the Standard plans. Blocks shall be laid in courses with parting strips between the blocks in each course. Such parting strips shall be of wood or steel not more than one inch thick and with a width equal to the specified thickness of slab. The slabs shall be finished with a wood float and the joints along parting strips shall be finished with an edging tool. All joints shall be perpendicular to the slope. Blocks shall be laid in successive courses, and the joints between blocks in each course shall break joints with those in the preceding course.

Concrete shall conform to the requirements for Class B concrete, proportioned, mixed, placed and cured as prescribed in Section 2403.

**2507.04 METHOD OF MEASUREMENT.** The area of revetment constructed shall be measured by the Engineer, in square yards along the surfaces as constructed.

**2507.05 BASIS OF PAYMENT.** The contract price per square yard for revetment shall be full payment for furnishing all materials and performing all labor, including all excavation and back filling necessary to complete the work in accordance with the plans and these specifications.

## Section 2508. Painting Steel Structures

**2508.01 DESCRIPTION.** The painting of steel structures shall include the proper preparation of the surfaces to be painted, the application, protection and drying of paint coatings, the protection of all parts of the structure against disfigurement from spatters and splashes of paint, and the supplying of all tools, scaffolding, labor and material necessary



for the work. All steel structures and metal for structural steel construction purchased under these specifications shall be subject to the detailed requirements of this section.

**2508.02 MATERIALS.** All paint for structural steel shall conform to the requirements of Section 4135 for the coating specified.

**2508.03 NUMBER OF COATS.** Except as otherwise specified on the plans, or in Section 2407, all structural steel included in contracts which include erection of the structural material, shall receive one shop coat and two field coats of paint complying with the following requirements:

Shop Coat—Paragraph 4135.04-B or 4135.04-C.

First Field Coat—Paragraph 4135.04-D or 4135.04-E.

Second Field Coat—Paragraph 4135.04-H.

**2508.04 PAINTING CONDITIONS.** No paint shall be applied to metal surfaces that are not entirely free from moisture or frost. Paint shall not be applied when the atmosphere surrounding the metal is at a temperature below 40 degrees Fahrenheit, except with the specific permission of the Engineer. No paint shall be applied under any condition of weather, temperature and humidity that, in the opinion of the Engineer, are unsatisfactory for painting.

**2508.05 CLEANING.** All metal shall be thoroughly cleaned before being painted. The cleaning shall remove all rust, loose mill scale, all weld spatter, slag and flux, and all grease and dirt. Except for surfaces covered by scaly rust, or pitted by rust, the cleaning may be done by thorough scraping or by the use of an approved flame cleaning device designed for this specific purpose, followed by thorough brushing with steel bristle brushes. Surfaces covered with scaly rust or pitted by rust shall be cleaned by sand blasting.

Oil and grease shall be completely removed by washing with gasoline or benzine, after which the surface shall be allowed to dry before paint is applied.

Just prior to the application of paint, all dust shall be removed from the surface to be painted, by means of a dry bristle brush.

Before the first field coat of paint is applied all spots on which the shop coat has been broken or marred, and all field rivets and connections shall be cleaned as specified above.

Before each field coat of paint is applied, the previously



painted surface shall be cleaned of any oil, grease or tallow by washing with gasoline or benzine, and the surface shall be allowed to dry before being painted.

**2508.06 CAULKING JOINTS BETWEEN CONCRETE AND STEEL.** Before field coats of paint are applied, all joints between painted structural steel members and concrete in either vertical or horizontal surfaces exposed to the weather, shall be caulked in accordance with the following provisions. The caulking recess in the concrete shall be cleaned of all loose concrete mortar or dirt and filled full with caulking compound. The compound used may be either plastic cement conforming with the requirements of Paragraph 4120.02-F or a caulking compound made by thickening paste white lead or paste red lead with whiting to a troweling consistency.

The steel and concrete surfaces shall be dry when the compound is applied. Care shall be used to place the compound in intimate contact and adhering to both concrete and steel. Care shall be used to avoid smearing adjacent surfaces with the compound. The compound may be applied with trowel or with a caulking gun.

**2508.07 MIXING PAINT.** Before paint is applied, it shall be thoroughly mixed so that the pigment is completely in suspension and the consistency is uniform. It shall be kept at this uniform consistency while being applied. No thinning of paint will be permitted.

**2508.08 APPLICATION.** Paint may be applied by hand brushes or by suitable power sprays. By either method, the coating of paint applied shall be smoothly and uniformly spread so that no excess paint will collect at any point. To secure proper application by spray methods, the paint shall be brushed out wherever necessary to produce a result equal to that obtained by first class brush work. When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform, even coating in close contact with the metal or with previously applied paint. The brushes shall be round or oval in shape. On surfaces, other than the inside surfaces of pipes, which are inaccessible to a brush, the paint shall be applied by properly constructed sheep skin daubers. The inside surfaces of pipes shall be coated by dipping or by filling the pipe with paint and draining out the excess.

Power spraying equipment shall apply the paint in a fine, even spray without the addition of thinner. In cool weather



the paint may be warmed to reduce its viscosity. Such warming shall be accomplished by placing the containers in water, or by placing them on steam radiators.

Before the first field coat is applied, all spots in the shop coat that have been marred or broken in shipping, handling and erection, and all field rivets and field connections shall be cleaned as specified in Article 2508.05, and shall be given a coat of paint as specified for shop coat, which shall be allowed to dry as specified in Article 2508.09.

**2508.09 DRYING.** Each coat of paint shall be allowed to stand a sufficient length of time to permit the film to dry thoroughly throughout its entire thickness before the next coat is applied. This time will vary with weather conditions, but shall not be less than 7 days, under the most favorable conditions. During the drying period, the shop coat shall be protected from cinders, sand or dirt. The shop coat shall be thoroughly dry before the metal is loaded for shipment.

**2508.10 RATE OF APPLICATION.** The quantity of paint applied per coat per ton shall not be less than 0.3 gallons for I-beams, and 0.4 gallons for fabricated shapes. The Engineer shall be afforded every opportunity to check the quantity of paint actually applied to a structure.

**2508.11 PAINTING OLD STRUCTURES.** For painting old structures, the special provisions will stipulate the type and extent of cleaning, the number of coats, and the kinds of paint to be used.

**2508.12 BASIS OF PAYMENT.** The painting of new structures will not be paid for separately, but will be considered as incidental to the fabrication and erection of structural steel, the cost to be included in the contract price for the steel.

Contracts for painting old structures may provide for payment of a lump sum for cleaning and painting an individual structure, or for a price per gallon of paint applied as stipulated in the special provisions. These contract prices shall be full payment for furnishing all materials, tools, scaffolding, and other equipment and, for performing all cleaning and other work necessary to complete the work in accordance with these specifications.



## Section 2509. Painting Woodwork

**2509.01 GENERAL REQUIREMENTS.** All wood railings on timber trestle bridges and all other exposed wood surfaces designated on the plans shall be given three coats of white paint conforming to the requirements of Paragraph 4135.04-A, except that the first coat on creosoted lumber shall be aluminum paint, Paragraph 4135.04-F.

For the first coat of paint applied, the paint may be thinned by adding to five gallons of paint, one quart of raw linseed oil and one quart of turpentine or mineral spirits. No thinning of the paint used for other coats will be permitted.

The provisions of Article 2508.04 and 2508.09 inclusive, shall apply to the painting of woodwork, except that sand blast or power driven brushes shall not be used for cleaning.

For all coats except the priming coat, the paint shall be applied at approximately the following rates.

Aluminum paint .....	600 square feet per gallon
Other paints .....	500 square feet per gallon

Each coat shall be thoroughly dry before a succeeding coat is applied.

**2509.02 BASIS OF PAYMENT.** The painting of woodwork on new construction will not be paid for separately, but shall be considered as incidental to such construction and the cost thereof to be included in the contract prices for the construction.

## Section 2510. Waterproofing and Damp Proofing

**2510.01 GENERAL.** Concrete structures shall be waterproofed or damp proofed as designated on the plans and in the manner herein provided. When specified on the plans a protective coat of either asphalt plank or Portland cement mortar shall be applied over the waterproofing coat. All waterproofing specified on the plans shall be construed to refer to the hot application membrane waterproofing specified herein, unless otherwise specifically provided.

**2510.02 MATERIALS.** All materials used in waterproofing or damp proofing shall conform to the requirements of Part IV for the respective materials as follows:

Primer, Cement, Saturated Fabric and Plastic Cement—Article 4120.02.

Asphalt Plank Protection Coating—Article 4120.11.



The whitewash used to coat the waterproofed or damp-proofed surfaces shall be composed of hydrated lime, whiting and casein glue in the following proportions, with sufficient water for proper application:

Whiting .....	not more than 80%
Hydrated Lime .....	5 to 10%
Casein (Alkali Soluble).....	15 to 20%

**2510.03 MEMBRANE METHOD.** (Hot Application). The membrane waterproofing shall consist of a bituminous priming coat and two complete layers or plies of woven cotton fabric saturated with bituminous substances, laid in and cemented with a bituminous cement. Either tar or asphalt may be used as the primer, the cement and the saturant of the fabrics, but for any one structure only one type of bitumen may be used.

**A. Preparation of Surface.** The surface of the concrete to be treated shall be smooth and free from all sharp projections, dirt, dust or loose materials. Sharp projections which might injure the waterproof coating or prevent its adhering to the surface of the concrete shall be chiseled off and all dust or dirt carefully removed by means of brooms. The surface to receive the waterproofing shall be thoroughly dry.

**B. Method of Construction.** The waterproof coating shall consist of a priming coat and two complete layers of fabric saturated with bitumen cemented together and to the structure, and the entire surface sealed by mop coats of bituminous cement.

The entire surface to be covered shall be brushed or sprayed with the primer at a rate of approximately 0.1 gallon per square yard. The amount of coating shall be sufficient to absorb any loose dust particles and provide a thin, continuous layer of bitumen adhering to the concrete. The primer coat shall set thoroughly before additional material is applied.

When the primer coat has thoroughly set, the bituminous cement shall be mopped over the surface. The bituminous cement shall be heated to a temperature within the following limits which will make it thoroughly liquid, but care shall be used to avoid injuring the material:

Tar Cement .....	200-250° F.
Asphalt Cements .....	300-350° F.



The application of mop coat shall be started at the lower portion or portions and proceed to the highest portion of the surface. The mop coat shall be applied in horizontal strips.

The first strip shall be half the width of the saturated fabric and a half width strip of fabric shall be spread on the freshly mopped surface. All wrinkles and air bubbles shall be removed and the fabric pressed tightly into the cement. The surface of this fabric strip and the adjacent concrete surface shall then be mopped with hot cement and a full width strip of the fabric applied and carefully smoothed. The surface of the upper half of this strip and an additional strip of concrete shall be mopped and a third strip of this fabric applied. Successive strips shall be applied in this manner until the entire surface is covered.

In lieu of using horizontal strips in waterproofing arch rings, the fabric over the barrels of arches may be placed in strip extending parallel to head walls or spandrel walls.

Beginning at the down stream end, place a half width strip over the barrel of the arch parallel to the head wall or spandrel wall and extending up the spandrel wall at least 3 inches. Where it is necessary to make this sheet fit smoothly the up-turned portion may be slit. Strips shall then be placed on the back of the spandrel wall at right angles to this first strip and extending from the flashing notch to the full width of the first strip placed. Placement of these strips shall begin at the lower points and progress toward the crown of the arch with each strip lapping the preceding one by one-half width along the flashing notch.

Following the placement of these short strips, full width strips shall be placed over the barrel of the arch with the edge of the first strip against the back of the spandrel wall. Each successive strip of fabric shall lap at least 2 inches over the upper edge of the second sheet below. Where it is necessary to splice strips of fabric, the ends shall be lapped at least one foot. On the barrels of arches and all horizontal surfaces, the ends of the waterproofing strips shall be carried up the adjacent vertical walls at least one foot to the flashing notch. At all drainage openings the fabric shall be carefully



turned and mopped so that no water can get under the fabric. After the fabric has been applied, all exposed edges, laps and flashing shall be given an extra coat of cement and the entire surface shall be thoroughly mopped with the hot cement. The amount of cement applied shall not be less than 12, nor more than 14 gallons per 100 square feet of finished work.

Waterproofing shall be applied only in good weather, when the surface is thoroughly dry and the air temperature is above 40° F. The work shall be so scheduled that none of the fabric surface is left over night without being mopped with hot cement.

C. **Protective Coating.** When specified on the plans a protective coating shall be applied over the waterproofed surface. This protective coating shall consist of asphalt plank or Portland cement mortar as specified.

1. **Mortar Protective Coat.** The mortar coating shall conform to the requirements for class "C" concrete, Section 2403. This layer shall be placed in a uniform layer 1½ inches thick over the area specified and shall be finished smoothly with a wood float. Care shall be used that the waterproofing is not injured when the concrete is placed and that the concrete is cured by covering with burlap, kept wet for seven days and in cold weather protected as specified in Paragraph 2403.13.

2. **Asphalt Plank Coating.** The asphalt plank shall be 1" thick. The plank shall be placed tightly together in a fresh mopping of the waterproofing asphalt, and all cracks or openings left between the planks poured full of asphalt.

**2510.04 DAMP PROOFING.** (Cold Application.) When specified on the plans or in the special provisions, surfaces of bridge structures shall be damp proofed by coating the surface with the materials and in the manner hereinafter specified.

(a) **Preparation of Surface.** The surface to which the damp proof coating is to be applied shall be cleaned of all loose and foreign material and dirt. When necessary the Engineer may require the surface to be scrubbed with water and a stiff brush, after which the surface shall be allowed to dry before application of the primer.



- (b) **Priming.** When the surface has been prepared, the primer shall be applied by brushing or spraying uniformly over the entire surface. The primer shall be applied at not less than 0.1 gallon per square yard. This coating shall be allowed to become dry and thoroughly set before additional coatings are applied.
- (c) **Joints.** All construction joints, expansion or contraction joints, shall be given special treatment after being primed by the application of a layer of plastic cement into which a strip of bituminous treated fabric shall be pressed. The surface for at least 1.0 foot on each side of the joint shall be coated with plastic cement troweled smoothly to a thickness of not less than 1/16 inch. Into this plastic cement shall be pressed a strip of fabric extending at least 8 inches on each side of the joint. Over expansion joints a fold of the fabric equal to the width of the expansion joint shall be pressed into the joint. This fabric shall be spread smoothly and pressed firmly into the asphalt. Adjacent strips of fabric shall be lapped at least 8 inches. If there is insufficient plastic cement in this coating to cause the fabric to adhere and stay in place, additional plastic cement shall be troweled on top of the fabric to secure satisfactory bond with the coating beneath. This coating shall be allowed to set and become firm before any additional coatings are placed. Care shall be used to secure the complete coating and proper placing of the fabric. These strip coatings shall be thoroughly set before subsequent coatings are applied.
- (d) **Plastic Cement Coatings.** After the surface has been primed and all joints treated with fabric strips, the entire surface shall be covered with two coats of plastic cement, each not less than 1/16 inch thick, applied at normal air temperature. Each coating shall be smoothly and neatly troweled in place so that no gaps or holes remain in the coatings. The first coating shall be allowed to dry and become firm before the second coating is applied. The amount of plastic cement used shall not be less than 4.0 gallons per 100 square feet for each coating.

**2510.05 BACK-FILLING.** The waterproofing or damp-proofing shall be set before any back-filling is placed against it. Care shall be used that no rocks be placed in the back-fill



within one foot of the coated surface and that the surface shall not be damaged by manipulation of tools or equipment in the operation of placing or consolidating the back-fill.

**2510.06 WHITEWASH.** When the contract for the structure does not include placement of back-fill over a surface which has been waterproofed or damp proofed, this surface shall be coated with whitewash. The proportions shall be such as will produce a uniform white color completely covering the treated surface.

**2510.07 BASIS OF PAYMENT.** Waterproofing and damp-proofing will be paid for at the contract price per square (100 square feet) for the coating specified. This contract price shall be full payment for furnishing all materials, tools, labor and equipment necessary to complete the waterproofing or damp proofing, including any protective coating specified and whitewashing the surface all in accordance with the plans and these specifications.

## Section 2511. Portland Cement Concrete Sidewalks

**2511.01 DESCRIPTION.** This work shall consist of construction on a prepared subgrade of sidewalk of Portland cement concrete of materials and methods specified in accordance with the plans and these specifications. Unless otherwise specified in the contract documents the minimum thickness of sidewalks shall be 4 inches.

**2511.02 MATERIALS.** The materials used shall conform to the requirements for the respective materials as specified in Part IV.

**2511.03 CONCRETE AND PROPORTION.** The concrete shall be prepared and proportioned in accordance with the requirements of Section 2403.

**2511.04 CONSTRUCTION.** The construction of concrete sidewalks shall conform to the following requirements:

- (a) **Preparation of Subgrade.** The subgrade upon which concrete sidewalk is to be placed shall be prepared by excavating or filling with suitable earth to such depth below the finished grade line that when tamped or rolled until smooth, firm and hard, the subgrade will be uni-



form and at the required depth below the finished grade line.

- (b) **Forms.** Forms of wood or steel shall be used along each edge of sidewalk. These forms shall be set true to line and grade, and shall be held rigidly in place by stakes placed outside the form and flush with the top edge of the forms. All forms shall have a width equal to the full specified depth of sidewalk. Wood forms shall not be less than  $1\frac{1}{8}$  inches in thickness.
- (c) **Placing Concrete.** The subgrade shall be thoroughly moistened or covered with a layer of bituminous treated paper as specified for Concrete Pavement in Paragraph 2109.04. The concrete shall be deposited for the full depth of slab in one operation. It shall then be consolidated by tamping and the excess concrete screeded off flush with the forms. The edges adjacent to all forms, expansion joints, curbs or fixtures in the surface shall be thoroughly spaded for the full depth.
- (d) **Finishing.** After consolidation, the concrete surface shall be finished with a wood float to a uniform granular texture true to line and grade specified on the plans. Unless otherwise shown on the plans, the finished surface shall have a cross slope of one-fourth ( $\frac{1}{4}$ ) inch per foot for drainage. When tested with a straight-edge which spans the blocks into which the walk is marked, the surface shall not show a variation from the required plane more than one-eighth ( $\frac{1}{8}$ ) inch.
- After the surface has been floated, the edges of the slabs shall be finished with suitable edging tool. Surface shall be marked off into square blocks having an area of not less than nine (9) nor more than thirty-six (36) square feet. On these lines, the concrete shall be cut through for the entire depth with a pointed trowel or suitable spading tool and the concrete edged on both sides.
- (e) **Protection and Curing.** The concrete shall be protected after finishing with one of the methods specified in Paragraph 2301.24 except that impervious coatings producing black surface shall not be used unless specifically approved in writing by the Engineer.
- (f) **Expansion Joints.** Expansion joints shall be constructed at all points where the walk meets other walks, curbs, or fixtures in the surface, and at intervals not greater



than fifty (50) feet. These joints may be constructed by installing a strip of bituminous pre-moulded joint material or by wooden strip of the required thickness which shall be removed as soon as the concrete has aged sufficiently as not to be damaged by this operation. The opening left by the removal of these strips need not be filled unless specifically required on the plans.

**2511.05 MEASUREMENT.** The area of concrete sidewalks will be computed in square feet by the Engineer, from measurements of the finished surface. No deduction will be made for fixtures with an area of one (1) square foot or less.

**2511.06 BASIS OF PAYMENT.** The area of sidewalk measured as prescribed above will be paid for at the contract price per square foot. This price shall be full compensation for furnishing all materials, tools, labor and performance of all work required to complete the work in conformance with the plans and these specifications.



## DIVISION 26. ROADSIDE IMPROVEMENT

This work shall consist of shaping the right of way in accordance with provisions of Division 21, the seeding, sodding and mulching for control of surface drainage, the installation of plant material, and improvement of the right of way in accordance with the requirements of the plans and the following sections:

- 2601. Erosion Control.
- 2602. Installing Plant Material.

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### Section 2601. Roadside Erosion Control

**2601.01 DESCRIPTION.** Roadside erosion control shall consist of seeding, sodding, mulching, and control of surface drainage of the areas within and adjacent to the right of way in accordance with the plans and the following provisions.

**2601.02 MATERIALS.** The materials required in seeding, sodding and mulching shall conform to the following requirements:

**A. Grass and Legume Seed.** Unless otherwise provided, all grass and legume seed will be furnished by the County at the point designated. The specified grass mixture shall be prepared by the County prior to delivery. Legumes will be furnished unmixed to facilitate inoculation. Where special seed is to be applied to restricted areas, seed of varieties not included in the general mixture of grass seeds will be furnished separately.

All bags in which seed is furnished by the County shall remain the property of the County and shall be bundled and returned in good condition to the County Garage at which the seed was available to the Contractor.

Grass and legume seed furnished by the Contractor shall conform to the requirements of Section 4260.

**B. Stabilizing Crop Seed.** The seed for all nurse or stabilizing crops shall be furnished by the Contractor. Unless otherwise provided oats shall be used for the nurse crop in all seeding during May, June, July and to August 20,



and rye shall be used for nurse crop at all other times. All such seed shall be thoroughly recleaned and shall meet the requirements of the Iowa Seed Laws.

C. **Fertilizer.** Unless specifically noted on the plans or in the Special Provisions the term "fertilizer" shall be interpreted as meaning a commercial inorganic material having a guaranteed content as specified on the plans. Such guaranteed content shall express the total Nitrogen content, the available Phosphoric Acid content and the water soluble Potash content in that order (A 10-4-2 fertilizer contains 10% total Nitrogen, 4% available phosphoric Acid and 2% water soluble Potash). All fertilizer shall be in condition which will permit proper distribution.

D. **Sod.** Sod shall consist of the top 1½ inches of well established field turf consisting in the major part of live Kentucky Blue Grass, unless otherwise specified, grown on loam soil and shall be free from roots of trees or brush, stones and other objectionable materials. Sod shall be free from all noxious weeds. All sod shall be inspected and approved by the Engineer.

E. **Mulch.** Material used as mulch may consist of thrashed timothy heads, oat straw, barnyard manure containing 50% or more straw or other materials as approved by the Engineer. In those counties lying north of the 3 southernmost tiers of counties, the use of wheat straw or barley straw will be permitted. All material used as mulch shall be inspected and approved by the Engineer.

F. **Stakes.** Stakes for holding sod shall be 1 to 1½ inches in width, ¼ to ½ inch in thickness, 12 inches long and pointed. Where this length of stake does not provide firm bearing the Engineer may require stakes of length sufficient to secure firm bearing.

**2601.03 SEEDING.** Seeding shall include the operations of seed bed preparation, sowing and covering the seed and compaction of the seed bed on various portions of the right of way except the traveled portion of the road bed and on such other areas as may be indicated on the plans or as ordered by the Engineer. The limits of all areas to be seeded shall be clearly marked by the Engineer before the seed bed is prepared.

Any areas having a satisfactory growth of desirable grasses or legumes shall not be disturbed.



Seed shall be sown only at such time of the year when temperature, moisture and climatic conditions will promote germination and plant growth, and which will normally occur between March 1 and May 30, and August 10 and September 30. The seeding shall be in accordance with the following:

A. **Seed Bed Preparation.** The area to be seeded shall be smooth and all washes and gullies filled to conform to the desired cross section. Areas having gullies or washes 12" or less in depth measured perpendicular to the slope shall be filled by the Contractor without extra compensation. Gullies and washes of depth greater than 12" shall be filled and compacted in layers not greater than 4" loose thickness. Each layer shall be thoroughly tamped and the surface of adjacent banks broken down and compacted with the backfill material so that the new material will bond with the old. Unless a separate contract price has been provided, the work of filling gullies or washes of depth greater than 12 inches will be handled as extra work, Article 1109.04.

Areas accessible to horse drawn or power driven equipment shall be thoroughly worked to a depth of not less than three inches. Areas inaccessible to horse drawn or power driven equipment shall be prepared by hand to a depth of not less than one inch. The soil in the entire area shall be brought to a thoroughly loose and friable condition for the specified depth. Care shall be used that the entire width of shoulder and areas around flumes, headwalls and other structures are prepared in the manner specified.

Should weed growth develop after completion of grading operations and before seeding operations begin, the Contractor shall mow, rake and dispose of all such weed growth at his own expense.

B. **Preparation of Seed.** All legumes shall be inoculated with a standard product humus culture before being mixed with other seeds for sowing. The inoculant shall be furnished by the Contractor and shall be of a type approved by the Engineer. Care shall be used that during and after the process of inoculation, the seed shall not be exposed to sunlight for more than one-half hour. The seed shall be sown as soon as possible after inoculation. Legume seed which has stood more than eight (8)



hours after inoculation shall be re-inoculated before sowing.

- C. **Sowing of Nurse Crop.** After preparation of the seed bed the nurse crop shall be sown at the rate specified. This seed may be applied with a broadcast seeder, end-gate seeder or "cyclone" hand seeder. Care shall be taken to adjust seeders for the proper rate before seeding operations are begun.
- D. **Covering and Compaction of Nurse Crop.** The nurse crop, after sowing, shall be harrowed or disced in and rolled with the cultipacker wherever this machine can be operated satisfactorily.
- E. **Sowing of Grasses and Legumes.** On all areas accessible to horse drawn or power driven equipment all grasses and legume seed shall be sown with a broadcast type seeder only. (Also known as a "broadcast sower" and is not to be confused with endgate, "cyclone" or hand seeders.) Care shall be taken to adjust seeders for the proper rate before seeding operations are begun. The mixture in the hopper shall be agitated frequently to prevent segregation of the various sizes of seeds. If necessary, permission will be granted to mix approximately 10# per acre of the nurse crop with the grasses and legumes to facilitate their passage through the seeder. On areas inaccessible to horse drawn or power driven equipment the seed may be sown by hand seeders. Care shall be used that all these irregular areas are properly seeded.
- F. **Cover and Compaction of Grasses and Legumes.** The sowing of the grasses and the legumes shall be followed at once by rolling as provided for the nurse crop. The immediate rolling of the shoulders is necessary to prevent seed loss due to the air currents created by passing traffic. The covering action obtained by this rolling is all that will be required. Harrowing or discing of the grass and legume seed will be permitted only where a cultipacker cannot be operated satisfactorily.
- G. **Rate of Seed Application.** The regular mixture of grass and legume seed will be sown at a rate of 25 pounds per acre. Rye will be sown at a rate of 1 bushel per acre and oats at 1½ bushels per acre. The rate for special seed will be specified on the plans or Special Provisions.



H. Application of Special Seed. On certain areas designated on the plans or requested by the Engineer, a special seed or seed mixture in addition to the regular seed mixture may be required. Such special seed shall be applied at the rate specified as a separate operation either immediately before or immediately after the sowing of the regular grass mixture and before rolling. No additional work other than the sowing of the special seed will be required. This seed may be applied by hand seeders.

**2601.04 APPLICATION OF FERTILIZER.** Unless otherwise specified fertilizer shall be spread over the areas and at the rate designated on the plans or Special Provisions. All fertilizer shall be spread with a mechanical spreader which will secure uniform rate of application. On areas accessible to power driven equipment, fertilizer shall be spread after preparation of seed bed prior to the sowing of the nurse crop and no manipulation or mixing with the soil other than that incidental to sowing the nurse crop will be required. On areas inaccessible to power driven equipment, fertilizer shall be spread after the preparation of the seed bed and shall be thoroughly raked into the soil prior to sowing the nurse crop.

**2601.05 SODDING.** The areas to be sodded shall be those shown on the plans or designated by the Engineer. Prior to the shaping of the channels the Engineer will define the limits of the area and indicate the centerline of waterways to be sodded. The Contractor shall cover the designated areas with live sod closely placed and properly fitted against the structure and against adjacent sod in accordance with the following provisions:

A. Cutting of Sod. Sod shall be cut in strips of uniform width and to a uniform thickness of one and one-half ( $1\frac{1}{2}$ ) inches. Sod strips shall be not less than thirty-six (36) inches in length. When cutting sod to be laid in road ditch channels in which the sodded area is seven (7) feet or less in total width, the strips shall be cut in lengths equal to the width of the sodded area. Sod strips shall be cut with smooth, clean edges. If long grass interferes with cutting of smooth edges on sod strips for channels or intercepting ditches, the sod shall be mowed to a height approximately two (2) inches prior to cutting the strips. Sod strips may be rolled with the top inside, and shall be cut from turf of such texture and toughness



to permit handling and placing without breaking or tearing. Ends of strips shall be cut square to facilitate smooth laying and fitting.

Not more than eighteen (18) hours shall elapse between cutting and laying of sod. Precaution shall be taken during this period to prevent sod from drying out.

**B. Preparation of Sod Bed.** The Contractor shall prepare and shape all surfaces to be sodded. Areas shall have smooth even surface free from stones, boulders, roots or other debris. Washes and gullies shall be filled as provided in Paragraph 2601.03 (A), Seed Bed Preparation. All ditches, channels, slopes and flumes to be sodded shall have a typical cross section shown on the plans. Just prior to laying sod, the soil shall be loosened to a depth of 1 inch and thoroughly dampened if it is not already in a sufficiently moist condition.

**C. Placing Sod.** Sod shall be carefully placed in rows or strips. On slopes, the strips shall be transverse to the flow of water over the area. On the sides and bottom of ditches and channels the strips shall be at right angles to the center line of channel. Each sod strip shall be packed tightly so that no open joints are left between strips. Joints between ends of strips shall be staggered so they are not continuous from toe to top of slope or along channels. In sodding of channels or side ditches, at every 10th strip a sod "wing" shall be extended not less than 30 inches beyond the edge of the sodded channels. At the top of slopes or channels the edge of the sod shall be so laid as to conduct surface water over and on top of sod. The laying of the sod shall begin at the outlet or lower end of all flumes and work shall continue up the slope. On slopes, sodding shall begin at the bottom and work shall continue towards the top. If necessary, to protect sod already laid, the contractor shall furnish ladders or treaded planks for the use of the workmen without extra compensation.

Sod shall be well tamped with an approved type of tamper and shall remain firmly in place. All sod channels and sod flumes shall be staked to prevent sod from washing out and all sod placed on slopes 4 to 1 or steeper shall be staked to prevent sliding. Unless the Engineer has approved some equally effective alternate method of holding the sod in place, the sod shall be staked in the



following manner: All stakes shall be placed not more than thirty (30) inches apart in each strip and shall be driven at an angle against the direction of waterflow until they project  $\frac{1}{2}$  inch above the top of sod.

After sod has been laid in a channel or ditch, and prior to mulching of the strip adjacent to the sod, as specified in Article 2601.06, all areas disturbed during sodding operations shall be smoothed and raked, reseeded, and the seed raked in. The Contractor shall dispose of all waste materials and shall leave all disturbed areas in good condition. The sodded areas shall also be seeded without raking in the seed.

When sod channels are to be installed in wide ditches or borrow pits, extreme care shall be taken to make sure the installation of these channels is at the low points of such areas. All excavated material shall be wasted lightly over adjacent areas in such a manner as not to prevent water flowing into the channel.

D. **Watering Sod.** Before any sodding operation is begun the Contractor will be required to provide adequate watering equipment and water supply. Not more than one (1) hour shall elapse between the laying and the watering of the sod. This watering shall consist of a thorough soaking of the sod and the sod bed to a depth of at least one (1) inch below the sod. Care shall be taken to insure a thorough watering of the sides at the channel and the sod "wings" to the required depth. All sod shall be maintained in a moist and growing condition for thirty (30) days after completion of all sodding operations. At the end of this period Contractor will be required to replace, as above prescribed, any sod that is not in a moist and growing condition and maintain said replaced sod for an additional 30 days from date of replacement.

**2601.06 MULCHING.** All seeded areas of backslopes and foreslopes, five (5) feet or over in height, shall be mulched. Earth areas 5 feet wide adjacent to all sodded channels shall be mulched to prevent washing of silt onto the sod. Borrow pits which slope toward the highway and may be the source of silt filling the ditches shall be mulched for 20 feet outside of the right of way line. The Contractor shall also mulch any other areas as ordered by the Engineer. Mulching shall be done in accordance with the following provisions:



- A. **Time of Mulching.** All seeded slopes shall be mulched within 5 hours from the time the seeding of that surface is complete.
- B. **Application of Mulch.** The mulch shall be evenly and uniformly distributed to provide actual covering of 30% to 40% of the ground surface.
- C. **Reseeding.** Areas on which seeding, mulching, or both, are disturbed due to rain, the Contractor shall rework such areas at his own expense unless such areas have been accepted for maintenance by the Engineer. Seed only for reseeding operations will be furnished by the Commission.

**2601.07 INTERCEPTING DITCHES AND FLUMES.** Whenever the slope of the adjacent land toward the back slope of road excavations, and the extent of the area drained would result in sufficient water flowing over the back slope to cause serious erosion, ditches shall be constructed to intercept the flow of surface water and conduct it into proper drainage channels, as provided in Article 2102.08. These intercepting ditches and flumes shall conform to the typical designs shown on the plans. The earth excavated from the ditch shall be compacted to make the bank on the lower side of the ditch. The entire area of the ditch and flume sides and bottom shall be completely sodded.

**2601.08 COMPLETION OF WORK.** All phases of this work shall be so co-ordinated and completed that the Contractor's operation for any phase of the work will not extend more than 2 miles from portions already completed, except with written permission of the Engineer. All phases of this work except wetting of sodded areas shall be completed within the specified contract period and "completion-of-the-work" will be certified in the usual manner upon such completion. The wetting of sodded areas shall continue for full 30 calendar days after placing of the sod even though this period extends beyond the date on which other phases of the work have been completed and accepted. Upon satisfactory completion of the 30 day wetting of the sod, final payment for the project will be released subject to the customary regulations.



**2601.09 METHOD OF MEASUREMENT.** The Engineer will compute the areas which have been seeded, sodded and mulched in the following units:

- Seeding Acres (Slope Measurement)
- Sodding Squares of 100 sq. ft.
- Mulching Acres (Slope Measurement)
- Special Seeding Acres (Slope Measurement)

The amount of fertilizer applied will be measured in hundreds of pounds net weight. Unopened bags packed by the manufacturer will be accepted at the weight marked on them.

The estimated quantities of seeding, sodding, mulching, special seeding and fertilizer are approximate only. The final amount of each class of work completed will be determined by the Engineer and the provisions of Article 1109.03 shall not apply on these items.

**2601.10 BASIS OF PAYMENT.** For the areas which have been satisfactorily seeded, sodded, mulched, and for amount of fertilizer applied, in accordance with the plans and these specifications, or as ordered by the Engineer, measured as prescribed above, the Contractor will be paid the contract unit prices therefor. For the sowing of Special Seed over the areas mentioned the Contractor will be paid at 10% of the contract price per acre for seeding. The inoculation of seed, the smoothing and reshaping areas to be seeded and sodded, the application of water to sod, and furnishing mulch shall be considered incidental to the foregoing items and shall not be paid for separately. These unit prices shall be full compensation for furnishing all material, tools, and labor required to complete the work in accordance with the plans and these specifications, except the filling will be handled as extra work, Article 1109.04. No extra compensation will be allowed for filling gullies or washes which may form after the date to begin work on the contract.

## Section 2602. Installing Plant Materials

**2602.01 DESCRIPTION.** This work shall consist of furnishing plant material of the type, class, species, grade and size specified in the contract, and installing the same at the locations shown on the plans or designated by the Engineer in accordance with the following provisions:



**2602.02 MATERIAL.** Plant material furnished shall conform to the requirements of Section 4148.

- A. **Top Soil.** Top soil shall be high quality soil consisting of the top 6 inches of field or pasture loam containing a good supply of humus and a high degree of fertility. Surface soils from ditch bottoms, drained ponds and eroded areas or soils which are supporting growth of noxious weeds or other undesirable vegetation will not be accepted. Topsoil shall not be excessively acid nor excessively alkaline (pH value 6.0 to 8.5). It shall be free from hard lumps, rocks larger than 2 inches in diameter and woody roots.
- B. **Peat.** Peat shall consist of finely shredded partially decomposed fibrous vegetable matter of approved commercial grade, free from woody substances and weed seeds. It shall show only slight chemical reaction (pH 6.0 to 8.0) and shall be uniformly water absorbent. Peat shall be furnished in a dried condition.
- C. **Organic Fertilizer.** Organic fertilizer shall consist of well rotted cow manure containing not more than 50% straw, wood shaving, chips or other bedding material. It shall be free from creosote or other materials toxic to plant growth.
- D. **Stakes.** Stakes shall be 2x2 of the length specified, conforming to requirements for Class C lumber, Section 4138.

**2602.03 HANDLING AND TEMPORARY STORAGE.** During the handling at point of delivery and in transportation from temporary storage all plant material shall be maintained in good condition. All roots shall be protected by moist straw, moss or other suitable material and if necessary further protected with a tarpaulin.

When the Contractor is not able to set plants as soon as received they shall be heeled in at a location approved by the Engineer. All such heeled in material shall be maintained in a moist acceptable condition.

**2602.04 PLANTING SOIL.** Unless otherwise specified soil used for backfill around plantings shall be suitable humus bearing soil approved by the Engineer, which has been salvaged from excavation of the planting area, supplemented with topsoil, as specified. All planting soil shall be thoroughly mixed to uniform appearance and consistency.



**2602.05 LOCATION OF PLANTINGS.** The Engineer will stake the location of planting of each type of material specified. Location of trees will be staked individually before excavation for the planting is begun. The outline and number of plants for shrub beds will be indicated without staking location of individual plants. Plants shall not be set in rows or straight lines unless specifically required.

**2602.06 PLANTING.** All plant materials shall be planted in accordance with the following:

**A. Deciduous Trees.**

1. The excavation shall be dug according to the following table:

Size of Tree (Inches)	Excavation Diameter (Ft.)	Depth (Ft.)
½ to 1½	3	2
1¾ to 2¾	4	2
3 to 3¾	5	3
4 to 5¾	6	3
6 and over	As Specified	As Specified

2. After excavation is completed the soil in the bottom of the hole shall be loosened to a depth of six (6) inches. If the location is in an impervious soil, a suitable blind drain shall be installed to prevent water from standing in the hole.
3. All broken or cut roots shall be trimmed back to sound wood with a clean cut. Trees shall be planted not more than two (2) inches deeper than they grew in the nursery.
4. Before the tree is placed in the hole at least six (6) inches of backfill shall be placed in the bottom of the hole. Backfill shall be placed in a loose condition over roots, and carried up to a point three (3) inches from the top of the hole. Soil may be firmed slightly by tramping but vigorous tamping will not be permitted. When this backfilling has been completed the tree shall be thoroughly watered. Watering shall be done by inserting a hose to the bottom of the hole and running the water in at a slow rate. When backfill is moist throughout the watering shall stop.
5. After water is absorbed backfilling shall continue to a point three (3) inches from the finish grade line



and the soil firmed lightly to remove air pockets. A two (2) inch layer of peat mulch shall be applied followed with a one (1) inch layer of soil.

6. Trees shall be wrapped with krinkle kraft paper 4 inches wide. Wrapping shall extend from the ground line up to include approximately one-half of the crown in the case of thin barked trees (maple, sycamore, etc.). Wrapping shall extend to the third major branch in all thick barked trees.
7. After wrapping is completed all staking or guying shall be done as specified in Article 2602.09.

**B. Evergreen Trees and Shrubs.** This classification will also include any deciduous plant materials specified B & B.

1. Planting holes shall be excavated to a size which will permit eight (8) inches of backfill on all sides, but the bottom of the hole shall be firm undisturbed earth and deep enough to set the top of the ball at the finish grade.
2. After plant is placed it shall be backfilled for two-thirds ( $\frac{2}{3}$ ) the height of the ball and again lightly compacted by tramping.
3. The top one-third ( $\frac{1}{3}$ ) of the burlap covering shall be cut from the ball and removed from the hole. Care shall be exercised in doing this to avoid cutting off roots or damaging the ball. Immediately after removal of the burlap the backfilling shall be carried to a point three (3) inches from the top of the hole with loose uncompacted soil. At this point the plant shall be watered by inserting a hose to the bottom of the hole, as excavated, and running the water in at a slow rate. Watering shall continue until all the backfill is in a thoroughly moist condition.
4. After the water has been absorbed backfilling shall continue to a point three (3) inches from the top of the hole. A two (2) inch layer of peat shall then be applied followed by a one (1) inch covering of backfill material.
5. All evergreen and deciduous trees specified B&B shall be gayed as described in Article 2602.09.



**C. Deciduous Shrubs.**

1. Holes for deciduous shrubs shall be excavated 24 inches in diameter and 18 inches deep, measured on the low side on slopes, except for dwarf shrubs which shall be excavated to diameter equal to the average natural spread of the roots plus twelve (12) inches and 18 inches deep on the low side. All hedges shall be planted by the trench method. Trenches shall be twenty-four (24) inches wide and 18 inches deep on the low side in all cases. After excavations for shrub plantings are complete the soil in the bottom of the hole shall be further loosened to a depth of six (6) inches.
2. Shrubs shall be held in an upright position while backfilling. Backfill may be lightly tramped about the roots but no tamping will be permitted. Backfill shall be carried up to a point three inches below the finish grade line and then the shrub shall be watered as specified for deciduous trees and evergreens. Completion of backfill and application of peat shall conform to specification for deciduous trees and evergreen trees and shrubs.
3. Shrubs shall set not over two (2) inches deeper than they grew in the nursery. All shrubs which settle out of an upright position shall be straightened after watering and before the final backfilling is done.

**D. Vines and Ground Cover.** All vines and ground cover plants shall be planted in accordance with the specifications for deciduous shrubs.

**2602.07 WATERING.** All watering after that incidental to planting operations, shall be done by thorough sprinkling of the plant and the disturbed area surrounding it. At all times watering shall be done at extremely low pressure to prevent washing.

**2602.08 TRIMMING.** All trimming shall be done in accordance with the following:

**A. Deciduous Trees.**

1. All deciduous trees shall be cut back one-third ( $\frac{1}{3}$ ) to one-half ( $\frac{1}{2}$ ) their former leaf surface. All branches broken, damaged or otherwise defective, as well as all branches which may not develop properly, shall be



removed. Narrow crotches or competing leaders shall also be eliminated.

2. Street trees should be so pruned as to develop an upright leader. Flowering or specimen trees should be pruned to develop their natural form.

**B. Evergreen Trees and Shrubs.** All evergreens, when necessary, shall be pruned to develop their natural form. Exceedingly long branches competing with leaders shall be cut back to develop normal shape for the plant. Formal specimens may be sheared if so specified on the plans or in the Special Provisions.

**C. Deciduous Shrubs.** All deciduous shrubs shall be cut back to approximately  $\frac{1}{2}$  their former leaf surface. All pruning shall be done selectively to remove the older stems, and only in the case of clipped hedges will the use of hedge shears be permitted. All dead, broken, damaged or irregular branches shall be removed.

**D. Vines and Ground Cover.** Only broken, damaged or dead portions shall be removed from vines and ground cover plants.

**E. Painting.** Where branches cut are over  $\frac{1}{2}$  inch in diameter they shall be painted with an approved type of antiseptic tree paint.

**2602.09 STAKING AND GUYING.** After planting is complete the Contractor shall immediately stake all trees over one (1) inch diameter. Trees 1" to 2" in diameter shall be staked with one 2"x2" stake reaching approximately  $\frac{1}{2}$  the height of the tree after being driven until firm. Stake shall be attached to tree with #12 galvanized wire encased in new fabric reinforced rubber hose. Trees from 2" to 4" in diameter shall be staked with two stakes placed on opposite sides of the tree. These stakes shall extend up at least seven (7) feet from the ground. Stakes shall be fastened to the tree with #12 galvanized wire encased in new fabric reinforced rubber hose. Trees over 4" in diameter and all B&B trees shall be guyed with three guys equally spaced about the perimeter of the tree. Guys shall be attached to the tree at a point  $\frac{3}{4}$  of the distance from the ground to the top by means of a collar of #9 galvanized wire encased in fabric reinforced rubber hose. Guys shall be #9 galvanized wire and shall be attached to stakes 2"x4"x18" driven into the ground in line with the pull. Stakes shall be placed at a distance from the trunk of the tree equal



to  $\frac{1}{2}$  the distance from the ground to the point where the collar is attached.

**2602.10 MAINTENANCE.** The Contractor shall maintain all plantings in a neat and growing condition until such time as the project is accepted by the County. The Contractor may be required to replace at his own expense any plant material not in a live and growing condition at the date of acceptance. Exception will be permitted on Fall planting where material may be dormant at time of acceptance.

**2602.11 CLEANUP.** The Contractor shall dispose of all excess soil from excavations as directed by the Engineer. All packing materials, burlap, brush, limbs and other trimmings shall be burned or otherwise disposed of. All areas disturbed shall be left in a neat and orderly manner. All cleanup work will be considered incidental to construction work and no extra compensation will be allowed.

**2602.12 METHOD OF MEASUREMENT.** All plant materials will be counted in place. Peat and topsoil will be measured by the cubic yard in the transporting vehicle. Fertilizer will be computed by the cubic yard in the transporting vehicle for organic fertilizers and in hundred of pounds for commercial inorganic fertilizers.

**2602.13 BASIS OF PAYMENT.** All plant materials, peat and fertilizers will be paid for at the contract unit prices. These prices shall be full payment for furnishing materials, tools, labor and performing all incidental work necessary to complete the work in accordance with the plans and these specifications, including staking, guying and the installation of blind drains where necessary.



## PART IV

### MATERIALS

#### DIVISION 41. CONSTRUCTION MATERIALS

This part consists of requirements for materials used on various types of construction or maintenance as set forth in the following sections:

- Section 4101. General Provisions.
- Section 4102. Portland Cement.
- Section 4103. Water for Concrete and Mortar.
- Section 4104. Fine Aggregate for Concrete.
- Section 4105. Fine Aggregate for White Concrete.
- Section 4106. Fine Aggregate for Mortar.
- Section 4107. Coarse Aggregate for Concrete.
- Section 4107A. Class V Aggregate for Concrete.
- Section 4108. Granular Surfacing Material (Material for Gravel Surfacing.)
- Section 4109. Material for Rolled Stone and Soil Aggregate Base Courses.
- Section 4110. Material for Stabilized Surface Course.
- Section 4111. Cover Aggregate.
- Section 4112. Aggregate for Dense Graded Bituminous Surface Course, Road Mix or Plant Mix.
- Section 4113. Revetment Stone.
- Section 4114.
- Section 4115.
- Section 4116.
- Section 4117.
- Section 4118.
- Section 4119.
- Section 4120. Bituminous Material.
- Section 4121. Corrugated Metal Culvert Pipe.
- Section 4122. Corrugated Metal Subdrain Pipe.
- Section 4123. Sectional Plate for Pipe and Arches.
- Section 4124. Concrete Culvert Pipe.
- Section 4125. Cast Iron Culvert Pipe.
- Section 4126. Clay Culvert Pipe.
- Section 4127. Drain Tile.
- Section 4128. Sewer Pipe.
- Section 4129. Brick.



- Section 4130. Guard Rail Cable and Fittings.
- Section 4131. Steel Reinforcement.
- Section 4132. Structural Steel.
- Section 4133. Rivet Steel.
- Section 4134. Miscellaneous Iron and Steel.
- Section 4135. Paints.
- Section 4136. Wood Preservatives.
- Section 4137. Preservative Treatment.
- Section 4138. Untreated Timbers and Lumber.
- Section 4139. Treated Timbers and Lumber.
- Section 4140. Steel Piles.
- Section 4141. Concrete Piles.
- Section 4142. Timber Piles.
- Section 4143. Wood Posts.
- Section 4144. Subgrade Paper.
- Section 4145. Curing Paper.
- Section 4146. Burlap for Curing Concrete.
- Section 4147. Liquid Curing Compounds.
- Section 4148. Plant Material.
- Section 4149. Miscellaneous Materials.

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### Section 4101. General Provisions

**4101.00 SPECIFICATIONS REFERRED TO.** All references to A.S.T.M. specifications or A.T.S.M. methods of test shall be construed to mean the latest specifications or methods of test adopted, prior to the date of contract, by the American Society for Testing Materials for the material or the method of test indicated by the reference quoted.

All references to A.A.S.H.O. specifications or A.A.S.H.O. methods of test shall be construed to mean the latest specifications or methods of test adopted, prior to the date of contract, by the American Association of State Highway Officials for the material or the method indicated by the reference quoted.

**4101.01 SOURCE OF SUPPLY.** Materials complying with these specifications will be accepted from any source of supply, except that the County Board reserves the right to reject the entire output of any source from which it is impossible to secure a continuous supply of satisfactory material, or a source where conditions are such that the use of unfit material can be prevented only by extraordinary methods.



The Engineer may require the taking and testing of preliminary samples of material from any source before that source is approved for the delivery of material on any contract.

The Contractor shall notify the Engineer as to the sources from which he expects to obtain materials in order that efficient arrangements can be made for their inspection.

**4101.02 METHODS OF SAMPLING AND TESTING.** Unless otherwise specified, the methods and apparatus used for sampling and testing materials shall conform to the American Association of State Highway Officials' Standard Methods of Sampling and Testing Highway Materials. Unless otherwise noted, percentage values contained in specification requirements are percentages by weight.

A. **Sieves.** The sieves used for testing materials shall be woven wire cloth sieves conforming to the A.A.S.H.O. specification M92.

B. **Units of Aggregate for Sampling.** Aggregates to be used for any purpose may be required to be separated into distinct units of not more than 100 tons, which units shall be kept separate for a sufficient time to provide for proper testing and inspection. The units for inspection of aggregates for Portland cement concrete shall not be less than 25 tons, except when a lesser quantity is required for the contract. Each of the units shall conform to the requirements specified for the kind of material represented, except that the ingredients for combinations of coarse aggregate for Portland cement concrete from different sources, to be proportioned separately by weight may be accepted under the following provisions:

The combination shall meet the requirements of Articles 4107.04 and 4107.06. The combination shall not contain more than 0.8 of the maximum percentage of any of the objectionable materials specified in Article 4107.05. Aggregates for use in such combinations will be accepted only with the specific approval of the Engineer and in accordance with the provisions stated in such approval, which shall include the maximum percentage of each of the objectionable materials which the aggregate from each source may contain and the



percentage of aggregate from each source which the combination must contain.

C. Freezing and Thawing Test. The freezing and thawing test of aggregate shall be performed in the following manner:

A representative sample shall be sieved on a No. 4 sieve and the portion passing the sieve discarded. In the case of concrete aggregate the portion of the sample retained on the No. 4 sieve shall be adjusted to the following gradation:

Passing Sieve	Retained on Sieve	Per Cent
1½ in.	1.0 in.	35
1.0 in.	¾ in.	25
¾ in.	½ in.	10
½ in.	⅜ in.	10
⅜ in.	No. 4	20

When the test is performed on samples from quarry ledges the sample shall be crushed and a sample of the above gradation prepared. In all other cases the gradation used shall be that found in the sample.

The sample thus prepared shall be saturated with water by subjecting it to an air pressure reduced to not more than 1.0 inch of mercury and then submerging it in water for 15 minutes. The water shall be introduced without breaking the vacuum in the chamber in which the sample is contained.

The sample shall be placed in water tight pans and liquid added to a depth of 0.25 inch in the pan. In the case of aggregates for concrete the liquid shall be a water-alcohol solution containing 0.5 per cent of alcohol. In the case of aggregates to be used for other purposes the liquid shall be water.

The sample shall be frozen by placing the sample containers in air maintained at temperatures between  $-5^{\circ}$  and  $-15^{\circ}$  F. and shall be thawed by immersing the sample and container in the same liquid as that placed in the sample container. The liquid shall be maintained at temperatures between  $65^{\circ}$  and  $75^{\circ}$  F.

One freezing and one thawing shall constitute one cycle. After the specified number of cycles, the sample



shall be sieved on a No. 8 sieve. The percentage passing the No. 8 sieve shall be reported as loss in the freezing and thawing test.

- D. **Test for Carbon in Soil.** The carbon content of soils shall be determined by the chromic acid method. This method determines the readily oxidizable carbon which represents about 76 per cent of the total carbon present in the sample. The calculations include a correction based on this figure. The procedure of the test is as follows:

1. **Solutions Required:**

Normal Potassium Dichromate 49.05 grams per liter.

Normal Ferrous Ammonium Sulphate 250 grams per liter  
5 per cent Sulphuric Acid.

Diphenylamine Indicator. One gram, dissolved in 20 cc water and 100 cc concentrated sulphuric acid.

Concentrated Sulphuric Acid.

The potassium dichromate shall be standardized by any one of the standard methods. The ferrous ammonium sulphate shall be titrated against 10 cc of the dichromate using the same procedure as for the carbon determination, except no soil is used.

2. **Procedure.** The soil for testing shall be oven dried and pulverized to pass the No. 40 sieve. Accurately weigh 1 gram of the soil into a 500 cc Erlenmeyer flask. Add from a pipette or burette 10 cc of normal dichromate solution, then add 20 cc concentrated sulphuric acid, shake the flask and allow to stand for 10 minutes. The solution will normally be brown or green with brownish tinge. If the solution takes on a definite green color, after the addition of the dichromate and sulphuric acid, it probably indicates a high carbon content, and an additional 10 cc of dichromate (or more) should be added so as to provide an excess of chromic acid in the flask. While waiting, weigh out 5 grams of sodium fluoride. After the flask has stood for 10 minutes, add 100 cc of water and the 5 grams of sodium fluoride and shake vigorously. Then add 5 to 6 drops of diphenylamine indicator and titrate with the normal ferrous ammonium sulphate until the color of the solution changes from blue to green.



## 3. Calculations:

Let: C=grams of actual carbon equivalent to 1 cc of solution of potassium dichromate.

D=grams of potassium dichromate per cc of standard solution.

F=cc of ferrous ammonium sulphate equivalent to 10 cc of potassium dichromate solution.

N=number of 10 cc lots of potassium dichromate solution added to the sample.

T=cc of ferrous ammonium sulphate required in titration of sample.

Then:  $C=0.0805D$

$$\text{Per cent carbon} = \frac{1000C (NF-T)}{F}$$

E. Test for Maximum Density and Optimum Moisture Content of Soils and Mixtures Containing Soil. The test for maximum density and optimum moisture of soils, soil mixtures and similar materials shall be conducted in accordance with A.A.S.H.O. Method T99, except that the sample may contain particles of all sizes passing a  $\frac{3}{4}$ -inch sieve. If the material being tested contains an appreciable percentage of particles retained on a  $\frac{3}{4}$ -inch sieve such particles shall be removed from the sample and be replaced with an equal amount of material passing a  $\frac{3}{4}$ -inch sieve and retained on a No. 4 sieve. The moisture content corresponding to the maximum density in this test is the "optimum moisture content" as used in these specifications.

F. Test for Solubility of Bituminous Materials in Carbon Tetrachloride. The test for the solubility of bituminous materials in carbon tetrachloride shall be conducted in accordance with A.A.S.H.O. Method T44, except that the solvent used shall be carbon tetrachloride.

G. Hveem Stability Test. The Hveem stability test for bituminous mixtures shall be performed in the following manner. A sample of the bituminous mixture shall be heated to a temperature of 140° F. A briquette 4 inches in diameter and 2 to 2 $\frac{1}{4}$  inches thick shall be formed from the heated material by tamping and by subjecting the specimen to a pressure of 3,000 pounds per square



inch. After being cooled to room temperature the specimen shall be tested in a Hveem stabilometer under a vertical pressure of 400 pounds per square inch and an initial side pressure of 5 pounds per square inch. The side pressure developed when the vertical pressure reaches 400 pounds per square inch shall be reported.

H. **Modified Hubbard Field Stability Test.** The modified Hubbard field test for stability of bituminous mixtures shall be performed in the following manner. A sample of the bituminous mixture shall be heated for 20 hours in an oven at a temperature between 215° and 225° F. It shall be sieved while hot through a No. 4 sieve. The portion of the sample passing the sieve shall be tested in accordance with the procedure described in the proceedings of the Asphalt Institute for 1928, with the following exceptions: The specimen shall be molded with a double plunger mold. The molding temperature shall be that specified in the specifications for the material being tested. The temperature of the specimen at the time of testing shall be 120° F. Specimens shall be tested 20 to 24 hours after being molded.

**4101.03 MEASUREMENT OF LIQUID BITUMINOUS MATERIALS.** Liquid bituminous materials will be measured in U. S. Standard gallons at a temperature of 60° F. Volumes measured at other temperatures will be corrected to a base of 60° F., using A.S.T.M. Volume correction tables as follows:

Designation D 206, Group O for asphaltic products having specific gravities of 0.966 and higher.

Designation D 206, Group 1 for asphaltic products having specific gravities from 0.8498 to 0.9659.

Designation D 633, Group O for tars of grades RT-1, RT-2, RT-3 and RT-4.

Designation D 633, Group OO for tars of grades RT-5 to RT-12 and RTCB-5 and RTCB-6.

Unless otherwise provided in the contract, the procedure in conjunction with all shipments in tank cars shall be as follows:

A. **Shipping Notice.** The producer shall furnish to the Engineer in charge of the project and to the Engineer of Materials and Tests copies of a shipping notice for



each tank car shipment, which notice shall contain the following information:

Car Number and Initials.

Type and Grade of Bitumen Contained.

Date of Shipment.

Shipping Point.

Routing of Shipment.

Destination.

Consignee.

Project Number.

Shell Capacity of Car.

Dome Capacity of Car.

Gross Gallons Loaded in Shell.

Gross Gallons Loaded in Dome.

Temperature of Bitumen, Degrees F., at Time Car Was measured.

Net Gallons Shipped at 60° F.

B. Field Measurement. Before each carload of bitumen is unloaded, the Engineer shall be given opportunity to make such measurements as are necessary to determine the net quantity of materials delivered.

C. Computation. The car measurements thus secured shall be sent to the Central Office of the Commission for computation of the net gallonage at 60° F. in the shipment. Copies of this computation will be furnished to the Engineer, the Contractor and the Company furnishing the bitumen.

**4101.04 MEASUREMENT OF SOLID BITUMENS.** All solid or semi-solid bitumens shall be measured in tons of 2,000 pounds, net weight, exclusive of tare weight of containers. In computing the net weight an average tare weight may be determined from the weight, before filling, of not less than 10 per cent of the number of containers in the shipment.

**4101.05 INSPECTION ARRANGEMENTS.** It shall be the duty of the Contractor to notify the Engineer of the source of the various materials required for each project. This notice shall be received sufficiently in advance of any shipment of materials that inspection may be arranged at the producing plant if the Engineer so elects. Whenever the quantity of material warrants such an arrangement, the inspection of all aggregates, cement, brick, reinforcing steel, bituminous materials, timber, lumber, piling and posts which are to be



come part of the completed work will be inspected at the point of production. For timber, lumber, piling and posts which are to be given preservative treatment this inspection will be performed at the treating plant in conjunction with inspection of the treating process.

Before inspection will be made the producer shall be furnished with a copy of the specifications which apply. Upon request of the Contractor, these specifications will be furnished by the Commission without cost. The producer shall have acquainted himself with the detailed requirements of the specifications.

For lumber and timber products the producer shall have sorted his stock and shall have segregated a sufficient quantity of material to insure that all of each item for inspection is available before the inspector is called. In the event that part of the shipment is rejected because of failure to meet the specification requirements the producer shall furnish other stock to replace the rejected items.

Should the quantity of any material rejected for failure to meet specification requirements amount to 20 per cent or more of the material required for the project, the inspection operation will be suspended until the producer shall have regraded his stock or revised his production methods to produce material conforming with the specifications.

In case the stock has not been properly prepared or segregated before calling an inspector, or in case of delay in replacement of rejected material the extra inspection cost occasioned by such delay may be charged against the Contractor for whom the material is being produced and may be deducted from any sums due or which may become due the Contractor.

Where a producer or jobber requests inspection of material for warehouse stock or for use in plants where stocks of materials inspected and accepted for use in highway construction or maintenance cannot be kept segregated from materials which have been used on other work, the cost of inspection of those materials which have been approved for highway work but are later diverted to other uses not connected with highway construction or maintenance may be charged to the producer or jobber who requested such inspections.

In the inspection of materials for warehouse stocks, any tolerances provided for inspection of individual shipments shall not apply.



## Section 4102. Portland Cement

**4102.01 GENERAL REQUIREMENTS.** Portland cement shall conform to the requirements of the A.S.T.M. specifications for the type specified for the work. Unless otherwise specified, Type I cement conforming to the requirements of A.S.T.M. Designation C150 shall be used. Where High Early Strength cement is specified, the cement shall conform to the requirements for Type III cement as specified in A.S.T.M. Designation C150. Where Air Entraining cement is specified, the cement shall conform to the requirements for Type IA cement as specified in A.S.T.M. Designation C175. Section 6 of A.S.T.M. Designation C175 shall be interpreted as meaning that the fact that the cement contains an air entraining agent must be shown in the marking specified.

**4102.02 TESTING.** Cement may be sampled either at the mill or at the site of the work. Cement sampled at the mill may be accepted upon passing the time of setting, fineness, soundness and air content of mortar requirements provided cement previously delivered from that mill has consistently complied with all the requirements of the specifications. In the event that a shipment of cement from any mill fails to meet any of the requirements of the specifications, the Engineer may require succeeding shipments from that mill to be held until completion of any or all the standard tests before being used.

Cement that has been stored at the site of the work or in local warehouses for more than 60 days shall be retested before being used. The Engineer shall be allowed sufficient time to complete 3-day strength tests on such cement. Any cement which has developed lumps from storage shall be screened through a screen having openings not larger than 0.05 inches in any dimension and only the cement passing through the screen shall be used. The Engineer shall be allowed sufficient time to complete 7-day strength tests on such screened cement.

## Section 4103. Water for Concrete and Mortar

**4103.01 GENERAL REQUIREMENTS.** The water used in concrete or mortar shall be clean, free from oil, salt or acid, organic matter or other substances injurious to the finished product. Where the source of water is relatively shallow, it shall be maintained at such a depth and the intake so enclosed as to exclude silt, mud, grass or other foreign material.



The water shall not be acid, nor excessively alkaline and shall conform to the following requirements:

- A. Hardness determined as calcium carbonate not more than ..... 300 ppm (0.03%)
- B. Organic matter not more than ..... 50ppm (0.005%)
- C. p H value ..... 7.0 to 9.0

The water shall comply with the suggested limits contained in Section 5 of A.A.S.H.O. Method of Test T26.

If at any time the water from any source becomes of unsatisfactory quality or insufficient quantity the Contractor may be required to provide water from some other source.

### Section 4104. Fine Aggregate for Concrete

**4104.01 DESCRIPTION.** Fine aggregate for concrete shall consist of clean, hard, durable rock particles free from injurious amounts of silt, shale, coal, organic matter or other deleterious substances and shall comply with the following requirements:

**4104.02 DELETERIOUS SUBSTANCES.** Fine aggregate shall comply with the following requirements:

- A. Shale and coal particles retained on a No. 16 sieve not more than 2.0 per cent.
- B. Organic matter, other than coal, not more than indicated by Figure 2 when tested in accordance with A. S. T. M. Method C40.

**4104.03 SIZE OF PARTICLES.** When tested by means of laboratory sieves the fine aggregate shall conform to the following requirements:

Sieve Size	Per Cent Passing
$\frac{1}{8}$ -inch .....	100
No. 4 .....	95 to 100
No. 8 .....	75 to 95
No. 30 .....	20 to 55
No. 200 .....	0 to 2.5

When fine aggregate is sieved through the following numbered sieves: 4, 8, 16, 30, 50 and 100, not more than 40 per cent shall pass one sieve and be retained on the sieve with the next higher number.

**4104.04 MORTAR STRENGTH.** The mortar strength of fine aggregate shall be determined in the manner prescribed in A. S.



T. M. Method C109, except that the fine aggregate being tested shall be substituted for the standard sand prescribed. The strength of such mortar shall not be less than 150 per cent of the strength of the mortar made from the same cement when tested in accordance with A. S. T. M. Method C109. Fine aggregate from any source from which samples have shown satisfactory mortar strength may be accepted without further mortar strength tests so long as its fineness modulus is not less than that of the fine aggregate from that source which showed a satisfactory mortar strength minus 0.30.

### Section 4105. Fine Aggregate for White Concrete

**4105.01 DESCRIPTION.** Fine aggregate for use in concrete specified as white concrete shall be silica sand conforming to the following requirements:

**4105.02 QUALITY.** The sand shall be composed of not less than 99.5 per cent silicon dioxide, and shall be free from measurable amounts of organic or foreign material.

**4105.03 SIZE OF PARTICLES.** When tested by means of laboratory sieves, the fine aggregate shall conform to the following requirements:

Sieve Size	Per Cent Passing
No. 30 .....	95 to 100
No. 50 .....	30 to 40
No. 100 .....	0 to 5
No. 200 .....	0 to 3

**4105.04 STORAGE.** Fine aggregate for white concrete shall be protected from the weather and from contact with materials which might stain or discolor it. If stored in bulk it shall be stored in tight, clean bins. Material which has become stained or discolored may be rejected.

### Section 4106. Fine Aggregate for Mortar

**4106.01 DESCRIPTION.** Fine aggregate for mortar shall consist of natural sand having durable grains free from injurious amounts of silt, shale, coal, organic matter or other deleterious materials. It shall comply with the following requirements.



**4106.02 DELETERIOUS SUBSTANCES.** Fine aggregate shall comply with the following requirements:

- A. Shale and coal particles retained on a No. 16 sieve not more than .....2.0 per cent
- B. Organic matter, other than coal, not more than indicated by Figure 2 when tested in accordance with A. S. T. M. Method C40.

**4106.03 SIZE OF PARTICLES.** When tested by means of laboratory sieves the fine aggregate shall conform to the following requirements:

Sieve Size	Per Cent Passing
No. 8 .....	100
No. 30 .....	40 to 75
No. 50 .....	10 to 40
No. 100 .....	0 to 30
No. 200 .....	0 to 3

**4106.04 MORTAR STRENGTH.** When tested as prescribed in Article 4104.04 the mortar strength of the aggregate shall not be less than that of the mortar made from standard sand.

## Section 4107. Coarse Aggregate for Concrete

**4107.01 DESCRIPTION.** Coarse aggregate for Portland cement concrete shall consist of gravel or crushed stone particles or combinations of these materials. The aggregate shall comply with the following requirements:

**4107.02 COMBINATIONS OF AGGREGATES.** Mixtures of crushed stone and gravel may be used, subject to the approval of the Engineer, provided the composition of the mixture is uniform and the grading of the mixture complies with the requirements of Article 4107.06.

Gravel pebbles combined with fine aggregate in the form of pit run or unscreened gravel may be used alone or in combination with separate crushed stone or screened gravel coarse aggregate to produce one of the proportions specified for concrete. The proposed source of supply and methods of preparing and handling unscreened gravel must be definitely approved by the Engineer before the material is delivered to the site of the work. The pit run or unscreened material shall comply with the requirements of Article 4107.07.



**4107.03 ABRASION LOSS.** The percentage of wear is determined in accordance with A.A.S.H.O. Standard Method of Test for Abrasion of Coarse Aggregate by use of the Los Angeles Machine T96. Grading A or B shall not exceed the following limits:

For Gravel .....	35.0
For Crushed Stone .....	45.0

**4107.04 SOUNDNESS.** At least 95 per cent of the particles of coarse aggregate shall be durable in themselves and have such characteristics as to have no adverse effect upon the durability of concrete in which the aggregate is used. In the determination of the soundness of coarse aggregate the Engineer may consider the results of the laboratory soundness tests prescribed below, the behavior of the aggregate under natural exposure conditions and the behavior of concrete in which the aggregate or aggregates similar as to geological origin have been used. Observations of the behavior of concrete may include both that exposed to natural weathering and that subjected to laboratory tests for durability. Unless the evidence outlined above indicates that for the aggregate from a particular source the test limits prescribed below provide an unreliable indication of the soundness of the aggregate, the material shall comply with the following requirements:

- A. **Loss in Sodium Sulphate Soundness Test.** The total weighted average loss in 10 cycles shall not be greater than 30 when the aggregate is tested with sodium sulphate in accordance with A. S. T. M. Method C88, Alternate B except that in testing samples from rock ledges the loss shall be computed to a sample having the grading specified in Paragraph 4101.02-C.
- B. **Loss in Freezing and Thawing Test.** The percentage loss in 16 cycles of the freezing and thawing test prescribed in Paragraph 4101.02-C shall not be greater than 6.0. In the routine inspection of coarse aggregate the percentage of unsound particles retained on the  $\frac{3}{8}$ -inch sieve will be determined by visual examination. The identification of particles as unsound will be based on the results of laboratory soundness tests of the aggregate.

**4107.05 MAXIMUM PERMISSIBLE AMOUNTS OF OBJECTIONABLE MATERIALS.** The percentage of objectionable substances shall not exceed the following limits:



Particles passing No. 200 sieve .....	1.5
Clay lumps .....	0.5
Coal and carbonaceous shale .....	0.5
Total of shale and coal combined .....	1.0
Sticks (wet weight) .....	0.1
Organic material other than coal and sticks .....	0.0

**4107.06 SIZE OF PARTICLES.** When tested by means of laboratory sieves the coarse aggregate shall comply with the following requirements for the respective uses, except that for use in reinforced masonry construction 100 per cent of the aggregate shall pass the 1½-inch sieve, regardless of the mix used:

Sieve Size	For Use in Concrete Pavement Or in Class A, Class B or Class X Masonry						For Use In Class C Masonry	
	Mix No. 1, 2, 3 or 4		Mix No. 2, 3 or 4		Mix No. 3 or 4		Min.	Max.
	Min.	Max.	Min.	Max.	Min.	Max.		
2 inch	100		100		100		100	
1½ inch	95	100	80	100	70	100	100	
¾ inch	35	70	30	80	20	90	100	
⅜ inch	10	30	10	40	5	50	50	
No. 4	0	5	0	5	0	5	0	5

For the proportions specified for the mixes of the various numbers see Articles 2301.12 and 2403.03.

**4107.07 PIT RUN OR UNSCREENED GRAVEL.** Pit run or unscreened gravel to be used in combination with screened gravel or crushed stone coarse aggregate shall contain not less than 60 per cent of particles which pass the No. 4 sieve. Pit run or unscreened gravel to be used without addition of separate coarse aggregate shall contain not less than 45 per cent of particles which pass the No. 4 sieve. The percentage passing the No. 4 sieve in pit run or unscreened gravel to be used at any single proportioning plant shall not vary more than 5 per cent from the average agreed to by the Contractor in securing approval of the Engineer for use of such material.

That portion of the unscreened gravel passing the No. 4 sieve shall conform to the requirements for Fine Aggregate for Concrete, Section 4104. That portion of the unscreened gravel retained on the No. 4 sieve shall conform to the requirements for coarse aggregate, except that when used in combination with screened gravel or crushed stone the gradation of the particles retained on the No. 4 sieve in the combined materials shall conform to the requirements of Article 4107.06 for the mix number in which it is to be used.



## Section 4107-A. Class V Aggregate for Concrete

**4107A.01 GENERAL.** Class V aggregate shall consist of a mixture of fine and coarse particles of decomposed feldspathic rocks having the gradation specified below and or such concrete making characteristics that mixtures specified in Article 2403.03 will be sufficiently plastic for use without exceeding the water cement ratios stipulated.

**4107A.02 GRADATION.** The gradation of particles of Class V aggregate shall be within the following limits:

Sieve Size	Per Cent Passing
1½ inch .....	100
No. 4 .....	80-92
No. 8 .....	60-75
No. 30 .....	25-35

In all other respects except gradation the portion of Class V aggregate passing the No. 4 sieve shall comply with requirements for Fine Aggregate for Concrete, Section 4104, and the portion retained on the No. 4 sieve shall conform to the requirements for Coarse Aggregate for Concrete, Section 4107.

## Section 4108. Granular Surfacing Material

(Material for Gravel Surfacing)

**4108.01 DESCRIPTION.** Material for the granular surfacing of roadbeds referred to in Section 2307 shall consist of a uniform mixture of fine and coarse particles of crushed stone, gravel or burned mine shale or of combinations of these materials with sand, which material or combination of materials shall comply with the following requirements for the class of material specified in the contract documents. Except when mixing on the road, has been approved by the Engineer, the materials as delivered on the road shall be of uniform gradation conforming to these specifications. When two sizes of materials are loaded in railroad cars the material shall be placed in not less than 5 layers so arranged that a uniform gradation will be produced by any system of unloading.

When gravel or crushed stone material is subjected to 25 cycles of the freezing and thawing test specified in Paragraph 4101.02 C the loss shall not exceed 15 per cent.

**4108.02 CLASS B GRAVEL.** Class B gravel shall consist of a mixture of sand and gravel complying with the following additional requirements:



Maximum percentage of shale particles retained on a No. 4 sieve .....	10
Maximum percentage of mud balls and particles passing the No. 200 sieve .....	15
Maximum percentage of the combination of the foregoing two items .....	20
Percentage passing $\frac{3}{4}$ -inch sieve .....	100
Percentage passing No. 4 sieve .....	50 to 75
Percentage passing No. 8 sieve .....	25 to 55

**4108.03 CLASS C GRAVEL.** Class C gravel shall consist of a mixture of sand and gravel complying with the following additional requirements:

Maximum percentage of shale particles retained on a No. 4 sieve .....	10
Maximum percentage of mud balls and particles passing the No. 200 sieve .....	15
Maximum percentage of the combination of the foregoing two items .....	20
Percentage passing $\frac{3}{4}$ -inch sieve .....	100
Percentage passing No. 4 sieve .....	50 to 80
Percentage passing No. 8 sieve .....	25 to 70

**4108.04 CLASS A CRUSHED STONE.** Class A crushed stone shall consist of a uniform mixture of coarse and fine particles produced by crushing rock and complying with the following additional requirements:

The percentage of wear as determined in accordance with A.A.S.H.O. Standard Method T96, Grading B, shall not be greater than ..	45
Maximum percentage of mud balls .....	8.0
Percentage passing $\frac{3}{4}$ -inch sieve .....	100
Maximum percentage passing No. 4 sieve .....	70
Percentage passing No. 8 sieve .....	30 to 45
Maximum percentage passing No. 200 sieve .....	25

**4108.05 CLASS B CRUSHED STONE.** Class B crushed stone shall comply with the requirements for Class A crushed stone except for the requirements as to size of particles which shall be as follows:

Percentage passing $\frac{3}{4}$ inch sieve .....	100
Percentage passing No. 8 sieve .....	10 to 45



**4108.06 BURNED MINE SHALE.** Burned mine shale shall consist of a uniform mixture of coarse and fine particles produced by crushing the shale waste from bituminous coal mines which has been thoroughly burned through spontaneous combustion. It shall be produced from sources approved by the Engineer and shall comply to the following additional requirements:

Maximum percentage of unburned particles retained on a No. 4 sieve .....	10
Minimum percentage passing 1½-inch sieve .....	95
Maximum percentage passing No. 8 sieve .....	50

### Section 4109. Materials for Rolled Stone and Soil-Aggregate Base Courses

**4109.01 DESCRIPTION.** The materials for rolled stone or soil-aggregate base courses shall comply with the following general requirements and with the detailed requirements for the respective kind of material specified in the contract documents.

- A. **Abrasion Loss.** The percentage of wear as determined in accordance with A.A.S.H.O. Standard Method T96, Grading A or B, shall not exceed 45.
- B. **Soundness.** When the gravel or crushed stone is subjected to 25 cycles of the freezing and thawing test specified in Paragraph 4101.02 C the percentage loss shall not exceed 15.

**4109.02 ROLLED STONE BASE MATERIAL.** The material for rolled stone base shall be a uniform mixture of coarse and fine particles produced by crushing limestone, dolomite or calcareous sandstone and complying with the following additional requirements:

- A. **Size of Particles.** Except as provided in Paragraph 2202.02 A, the material shall, when tested by means of laboratory sieves, comply with the following requirements:

Sieve Size	Percentage Passing	
	Min.	Max.
1½ inch .....	100	.....
¾ inch .....	75	100
No. 4 .....	40	75
No. 40 .....	15	35
No. 200 .....	9	22



- B. **Liquid Limit and Plasticity Index.** The liquid limit of the fraction passing the No. 40 sieve shall not be greater than 25 and its plasticity index shall not be greater than 8.

**4109.03 SOIL-AGGREGATE BASE MATERIAL.** The material for soil-aggregate base course shall be an accurately proportioned mixture of aggregate and soil binder and shall comply with the following additional requirements:

- A. **Aggregate.** Aggregate for the soil-aggregate mixture shall be a mixture of coarse and fine particles of gravel or crushed stone, a combination of these materials or a combination of these materials with sand. Clay and silt occurring naturally in the material will not be considered objectionable, provided it remains finely divided and uniformly distributed. The aggregate shall comply with the following requirements:

1. **Gravel.** Except as to size of particles, gravel shall comply with the requirements for gravel as specified in Section 4108.
2. **Crushed Stone.** Except as to size of particles, crushed stone shall comply with the requirements for crushed stone as specified in Section 4108.
3. **Sand.** For the purpose of this Article, sand will be considered as a separate material added to a soil-aggregate mixture and containing not more than 10 per cent of particles retained on a No. 4 sieve. Sand shall not contain more than 10 per cent of shale particles retained on a No. 16 sieve.

- B. **Binder Soil.** Binder soil shall have such characteristics as to impart to the soil-aggregate mixture the required properties. It shall not contain carbon in excess of 1.0 per cent. Before being mixed with the aggregate it shall be pulverized to such an extent that the finished mixture will not contain soil particles retained on a No. 4 sieve in an amount greater than 15 per cent of the amount of soil added.

- C. **Soil-Aggregate Mixture.** The mixture of aggregate and soil shall comply with the following requirements:

1. **Size of Particles.** When tested by means of laboratory sieves the mixture shall comply with the following requirements:



Sieve Size	Percentage Passing	
	Min.	Max.
1½ inch .....	100	-----
¾ inch. ....	75	100
No. 4 .....	45	85
No. 10 .....	35	70
No. 40 .....	20	35
No. 200 .....	9	22

The fraction passing the No. 200 sieve shall not be greater than one-half the fraction passing the No. 40 sieve.

2. **Liquid Limit and Plasticity Index.** The fraction passing the No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6.
3. **Laboratory Density.** The soil aggregate mixture shall be such that when compacted to maximum density at optimum moisture content the compacted mass shall contain not less than 81 per cent solid material.

## Section 4110. Materials for Stabilized Surface Course

**4110.01 DESCRIPTION.** Materials for stabilized surface course shall consist of a uniform mixture of coarse and fine particles produced by crushing limestone or an accurately proportioned mixture of crushed stone or gravel and sand combined with soil mortar and shall comply with the following additional requirements:

**4110.02 AGGREGATES.** The aggregates shall comply with the following requirements:

- A. **Crushed Stone.** Except as to size of particles, crushed stone shall comply with the requirements for crushed stone as specified in Section 4108.
- B. **Gravel.** Except as to size of particles, gravel shall comply with the requirements for gravel as specified in Section 4108.
- C. **Sand.** Sand shall comply with the requirements of Paragraph 4109.03 A 3.

**4110.03 BINDER SOIL.** Binder soil shall have such characteristics as to impart to the mixture the required properties. It shall contain not more than 1.0 per cent of carbon.



## Section 4112. Aggregate for Dense Graded Cold Laid Bituminous Surface Course

**4112.01 DESCRIPTION.** Aggregate for dense graded bituminous surface course shall consist of gravel or crushed stone or both combined with sand and filler and complying with the following requirements: The composite aggregate shall be free from vegetable matter and from adherent films of clay or other matter which will prevent the coating of the particles with bitumen.

**4112.02 GRANULAR AGGREGATE.** The granular aggregate shall consist of hard, durable rock particles complying with the following requirements:

- A. **Abrasion Loss.** The percentage of wear of the portion of the aggregate retained on a No. 4 sieve as determined in accordance with A.A.S.H.O. Method T96 shall not be greater than 45.
- B. **Soundness.** When the portion of the aggregate retained on the No. 4 sieve is subjected to 25 cycles of the freezing and thawing test specified in Paragraph 4101.02 C the percentage loss shall not be greater than 10.

**4112.03 FILLER.** The material used as filler to produce the desired percentage of particles passing the No. 200 sieve shall be pulverized limestone, volcanic ash, loess soil or other pulverized mineral matter approved by the Engineer. Filler shall be free from lumps retained on a  $\frac{3}{4}$  inch sieve and shall be in such condition that it may be readily incorporated into the mineral aggregate.

**4112.04 COMPOSITE AGGREGATE.** The composite aggregate shall comply with the following requirements:

- A. **Plasticity Index.** The portion of the composite aggregate passing the No. 40 sieve shall have a plasticity index not greater than 6.
- B. **Size of Particles.** When tested by means of laboratory sieves the composite aggregate shall comply with the following requirements for the size designation specified in the contract documents. Unless otherwise specified in the contract documents, the 1-inch size shall be used:



Sieve Size	Percentage Passing					
	1 Inch Size		¾ Inch Size		½ Inch Size	
	Min.	Max.	Min.	Max.	Min.	Max.
1 inch	100	100	100	100	100	100
¾ inch	85	100	100	100	100	100
½ inch	—	—	75	100	100	100
No. 4	45	65	50	75	70	100
No. 8	30	55	40	65	45	75
No. 30	20	40	25	45	30	50
No. 200	5	10	7	12	8	15

If the aggregate is produced by crushing ledge rock or boulders none of the fine material thus produced shall be removed from the aggregate without the approval of the Engineer.

**4112.05 UNIFORMITY OF GRADATION.** The proportioning of the various aggregates in the composite mixture shall be so controlled that variations from the average percentages passing the various sieves within any day's production will not be greater than the following:

Percentage passing the No. 4 sieve	5
Percentage passing the No. 8 sieve	5
Percentage passing the No. 200 sieve	2.0

### Section 4113. Revetment Stone

**4113.01 DESCRIPTION.** Stone for revetment shall be sound and durable. When subjected to 25 cycles of the freezing and thawing test specified in Paragraph 4101.02 C the percentage loss shall not be greater than 5. Rocks that split into layers less than 4 inches thick when exposed to natural weathering may not be used for revetment, regardless of the results of the above prescribed freezing and thawing test. The stone shall comply with the following additional requirements for the class of stone specified in the contract documents:

**4113.02 CLASS A.** The individual stones of Class A revetment stone shall not weigh less than 50 pounds and not more than 200 pounds. At least 75 per cent of the stones shall weigh more than 75 pounds. The stones shall have at least one flat face, with one dimension at least 15 inches.

**4113.03 CLASS B.** The individual stones of Class B revetment stone shall weigh not less than 50 pounds and not more than 200 pounds. At least 75 per cent of the stones shall weigh more than 85 pounds. The stone shall be produced from rock having definite bedding planes 4 to 12 inches apart. Individual



stones shall be as nearly rectangular as they can be broken practically, with two parallel faces and with one dimension 12 to 14 inches parallel to the bedding planes.

### Section 4120. Bituminous Materials

**4120.01 DESCRIPTION.** The provisions of this section cover requirements for bituminous materials to be used as coatings, as fillers, and as binders for mixtures. They also cover requirements for mixtures of bituminous materials with other materials and prefabricated units containing bituminous materials.

**4120.02 BITUMINOUS MATERIALS FOR WATERPROOFING AND DAMPPROOFING.** The bituminous materials used for waterproofing and dampproofing shall be of the types specified in the contract documents and shall comply with the following requirements for the type so specified:

- A. **Asphalt Primer.** Asphalt primer for use with asphalt for waterproofing or dampproofing shall comply with the requirements of A. S. T. M. Designation D-41.
- B. **Creosote Primer.** Creosote primer for use with tar for water proofing shall comply with the requirements of A. S. T. M. Designation D-43.
- C. **Asphalt Cement.** Asphalt cement for waterproofing shall comply with the requirements of A. S. T. M. Designation D449, Type A.
- D. **Tar Cement.** Tar cement for waterproofing shall comply with the requirements of A. S. T. M. Designation D450, Type A.
- E. **Cotton Fabric.** Woven cotton fabric for use with asphalt or tar in waterproofing shall comply with the requirements of A. S. T. M. Designation D173. The type of saturant shall correspond to the type of primer and bituminous cement used in the work.
- F. **Plastic Cement.** Plastic cement used for dampproofing shall be composed of fluxed natural asphalt or steam refined petroleum asphalt dissolved in suitable volatile petroleum solvents and stiffened with mineral filler consisting essentially of asbestos fiber.



The plastic cement shall be smooth and uniform in consistency and shall show no separation which cannot be easily corrected by stirring. It shall be of such consistency that it may be spread smoothly with a trowel and shall adhere well to wood, metal, concrete or fabric to which it is applied. It shall be furnished in sealed containers packed by the manufacturer and shall comply with the following additional requirements:

1. **Volatile Matter.** When a 10-gram sample of the plastic cement spread in a uniform layer  $1/16$  inch thick on a thin metal plate is maintained at a temperature of  $325^{\circ}$  F. for two hours the loss in weight shall not be greater than 10 per cent of the weight of the sample.
2. **Ash.** The percentage of ash as determined by igniting a 10-gram sample of the plastic cement shall not be less than 20 nor greater than 35.
3. **Consistency.** When tested with the ball penetrometer described below the penetration in 5 seconds at  $77^{\circ}$  F. shall not be less than 100 nor greater than 225.

The ball penetrometer shall consist of a spherical steel ball 0.663 to 0.667 inches in diameter, smoothly attached to a plunger  $3/16$  inches in diameter and approximately  $2\frac{3}{8}$  inches in length. The upper end of the plunger shall be turned down to  $\frac{1}{8}$  inch diameter to fit the standard penetrometer. The total weight of the plunger, including the ball, shall be adjusted to 75 grams.

4. **Setting.** A patch of plastic cement spread to a thickness of  $1/16$  to  $\frac{1}{8}$  inch on a metal plate shall show no blistering and shall not sag more than  $\frac{1}{4}$  inch after being exposed at laboratory air temperature for one hour, followed by 5 hours in a vertical position in an oven at  $140^{\circ}$  F.



5. **Brittleness.** A patch of plastic cement spread to a thickness of  $1/16$  to  $3/8$  inch on a thin metal plate shall show no cracking or evidence of brittleness when subjected to the following treatment: The specimen shall be heated in an oven at a temperature of  $140^{\circ}$  F. for 5 hours, after which it shall be cooled to laboratory air temperature. The specimen shall then be bent through an angle of 180 degrees around a mandrel having a diameter of one inch.

**4120.03 ASPHALT FILLER FOR BRICK AND BLOCK PAVEMENT.** Asphalt for filling joints in brick or block pavement shall comply with the requirements of A. A. S. H. O. specification M-18, Type A.

**4112.04 COMPOSITE AGGREGATE.** The composite aggregate materials for filling poured expansion joints and for sealing expansion joints in which preformed nonextruding joint fillers have been installed may be either of the following:

- A. Mixed asphalt and mineral filler complying with the requirements of A. A. S. H. O. Specification M89, penetration grade 40 to 50.
- B. Plastic cement complying with requirements of Paragraph 4120.02 F.

**4120.05 ASPHALT CEMENT.** Asphalt cement used as binder for mineral aggregate in base courses or surface courses shall comply with the requirements set forth below for the type and grade specified in the contract documents. In case no type is specified, either petroleum asphalt or native asphalt may be used.

- A. Asphalt cement prepared from petroleum shall be of the penetration grade specified in the contract documents and shall comply with the requirements of A.A. S.H.O. Specification M-20 and shall show a negative spot with standard naphtha solvent.



B. Asphalt cement prepared from Trinidad Lake Asphalt shall be of the penetration grade specified in the contract documents and shall comply with the requirements of A.A.S.H.O. Specification M-22.

**4120.06 CUTBACK ASPHALT, RAPID CURING TYPE.**

Cutback asphalt of the rapid curing type shall be of the grade specified in the contract documents and shall comply with the requirements of A.A.S.H.O. Specification M81. Unless otherwise specified in the contract documents, it shall show a negative spot with standard naphtha solvent.

**4120.07 CUTBACK ASPHALT MEDIUM CURING TYPE.**

Cutback asphalt of the medium curing type shall be of the grade specified in the contract documents and shall comply with the requirements of A.A.S.H.O. Specification M82. Unless otherwise specified in the contract documents, it shall show a negative spot with standard naphtha solvent.

**4120.08 SLOW CURING LIQUID ASPHALTIC ROAD MATERIAL.** Liquid Asphaltic Road material of the slow curing type shall be of the grade specified in the contract documents and shall comply with the requirements of the following:

- A. **Scope.** This specification covers liquid petroleum products of the slow curing type to be used in the treatment and construction of road surfaces.
- B. **General Requirements.** Each shipment of material shall be uniform in appearance and consistency and shall not foam when heated to 225° F. The residue of 100 penetration shall be smooth and homogeneous in appearance.
- C. **Properties.** The material of the grade specified shall conform to the requirements shown in the following table:



Temperature	Load in Pounds	Penetration in Inches
115° F.	50	Not more than 0.25
77° F.	200	Not more than 0.25
39° F.	1000	Not less than 0.10

Unless mineral surfaced plank are specified in the contract documents, plain plank shall be furnished.

## Section 4121. Corrugated Metal Culvert Pipe

**4121.01 DESCRIPTION.** Corrugated metal pipe for culverts shall comply with the requirements of A.A.S.H.O. Specifications M36, except that when so specified in the contract documents the pipe may be of the arch type. The pipe shall comply with the following additional requirements:

**4121.02 RIVETS.** Rivets shall be well formed, free from blisters, fins, seams, and splits in the metal. All rivets shall have a continuous coating of spelter of 0.15 to 0.40 ounces per square foot.

**4121.03 SAMPLING OF UNFABRICATED SHEETS.** Unless otherwise provided, unfabricated sheets will be sampled in accordance with the following provisions:

One strip of metal  $4\frac{1}{2}$  to  $5\frac{1}{2}$  inches wide shall be cut from the edge or the end of one sheet from each 500 sheets or fraction thereof of each gauge, heat and pot number. From each of these strips three samples each  $2\frac{1}{4}'' \times 2\frac{1}{4}''$ , or of equivalent area, shall be cut from near the newly sheared edge of the strip. These three samples shall be used for the determination of the weight of spelter coating and analysis of the base metal.

If any sheet fails to meet the requirements, a retest shall be made upon check samples taken from two other sheets of the same lot in accordance with the procedure given below. Both of these sheets shall meet the requirements of the specifications.

**A. Check Sampling Method.** A 3" strip shall be cut transversely or diagonally across the middle of the sheet, with its ends approximately 1" from each edge. Three samples  $2\frac{1}{4}'' \times 2\frac{1}{4}''$ , or of equivalent area, shall be accurately cut from the middle and the two ends of this strip.

**4121.04 LENGTH OF CULVERT PIPE.** The length of culvert specified shall be the net length of the finished cul-



vert, exclusive of material used to produce an end finish on the pipe. The following shall apply to contracts involving the furnishing of pipe only.

The average deficiency in length of any shipment of pipe shall not be greater than 1.0 per cent.

All pipe shall be furnished in the lengths ordered, with the following exceptions:

- A. No pipe shall be furnished in sections longer than 38 feet.
- B. In carload rail shipments, pipe for culverts more than 26 feet in length may be furnished in sections not less than 12 feet in length.
- C. In less than carload rail shipments, pipe for culverts longer than the lengths given in the following table may be furnished in the minimum number of sections which will produce the total length ordered without exceeding the section length given in the table:

Nominal Diameter of Pipe	Maximum Length of Section of L.C.L. Rail Shipment.
18" and under	22 feet
24"	20 feet
30"	18 feet
36"	16 feet
42"	12 feet

Suitable coupling bands shall be furnished for pipe shipped in two or more sections, which coupling bands will be paid for in accordance with provisions of Article 2417.07.

**4121.05 ELBOWS AND SPECIAL CONNECTIONS.** Where elbows and special connections are fabricated by methods which destroy the spelter coat, the elbows or special connections shall be regalvanized after fabrication or shall be made from metal 2 gages heavier than the gage of metal required for pipe of that diameter, but not heavier than 10 gage.

**4121.06 COUPLING BANDS.** All field joints shall be made with separate bands or with semi-circular bands which are securely riveted with at least one semi-circumferential seam to each section of pipe. The width of semi-circular riveted bands shall be not less than 7.0 inches for diameters of pipe



30.0 inches and smaller and 12.0 inches for diameters 36.0 inches and larger.

All bands shall be connected at the ends by angles having a minimum dimension  $2 \times 2 \times 3/16$ " and of length equal to the distance between crests of outside corrugations on the band plus 1". These angles shall be riveted to the band with not less than one rivet in the crest of each corrugation. The angles shall be coated with spelter by the hot dip process, after shearing to length and punching.

Bolts and angles for coupling bands shall have a coating of not less than 1.0 oz. spelter per square foot of surface, except on female threads.

**4121.07 HANDLING PIPE.** Pipe shall be handled carefully to avoid damaging the spelter coating. Pipe on which the spelter coating has been damaged may be rejected at the site of the work, regardless of the fact that the pipe may have been previously approved by the Engineer.

## Section 4122. Corrugated Metal Subdrain Pipe

**4122.01 DESCRIPTION.** Corrugated metal pipe for underdrains shall comply with the following requirements. Unless otherwise specified in the contract documents, the pipe shall be perforated.

**4122.02 TYPES OF PIPE.** Pipe may be any one of the following types:

- A. **Type I.** Helically corrugated pipe with a helical lock seam in diameters 6 to 21 inches, inclusive.
- B. **Type II.** Helically corrugated pipe with a welded longitudinal seam in diameters 6 to 21 inches, inclusive.
- C. **Type III.** Circumferentially corrugated pipe with a welded longitudinal seam in diameters 6 to 21 inches, inclusive.
- D. **Type IV.** Circumferentially corrugated pipe with riveted lap joints in diameters 8 to 21 inches, inclusive.

**4122.03 SHAPE.** The pipe shall be of the full circle type.

**4122.04 HELICALLY CORRUGATED PIPE (TYPES I AND II) AND WELDED PIPE WITH CIRCUMFERENTIAL CORRUGATIONS (TYPE III).** Pipe with helical corrugations shall have a continuous lock seam paralleling the corrugations,



or a continuous welded longitudinal seam extending from end to end of each length of pipe. Welded pipe with circumferential corrugations shall have a continuous welded longitudinal seam extending from end to end of each length of pipe. The lock seams and welded seams shall be fabricated in such a manner that they will not affect the shape or nominal diameter of the pipe and so that they will not create an element of weakness in the pipe.

Except as modified in this Article and in Articles 4122.06 to 4122.10, inclusive, pipe with helical corrugations (Types I and II) and welded pipe with circumferential corrugations (Type III) shall conform in all respects to the requirements of the Standard Specifications for Corrugated Metal Culvert Pipe, Designation M36, of the American Association of State Highway Officials.

**4122.05 RIVETED PIPE WITH CIRCUMFERENTIAL CORRUGATIONS (TYPE IV).** Riveted pipe with circumferential corrugations (Type IV) shall be fabricated so that, except for the perforations specified in Article 4122.07, it shall conform in all respects to the requirements of the Standard Specifications for Corrugated Metal Culvert Pipe, Designation M36, of the American Association of State Highway Officials.

**4122.06 CORRUGATIONS.** In pipe having a diameter of 10 inches or less, the corrugations in helically corrugated pipe (Types I and II) or in welded pipe with circumferential corrugations (Type III) shall be not less than  $1\frac{3}{8}$  inches or more than  $1\frac{7}{8}$  inches, center to center, measured at right angles to the direction of the corrugations, and they shall have a depth of not less than  $\frac{1}{4}$  inch. In pipe having a diameter of more than 10 inches and not more than 21 inches, the corrugations in pipe of Types I, II and III shall be not less than  $1\frac{7}{8}$  inches or more than  $2\frac{1}{4}$  inches, center to center, measured at right angles to the direction of the corrugations, and they shall have a depth of not less than  $\frac{7}{16}$  inch.

In riveted pipe with circumferential corrugations (Type IV) the dimensions of the corrugations shall conform to the requirements of the Standard Specifications for Corrugated Metal Culvert Pipe, Designation M36, of the American Association of State Highway Officials.

In helically corrugated pipe the angle between the direction of the corrugations and the longitudinal axis of the pipe shall not be less than 45 degrees. In circumferentially corru-



gated pipe the angle between the direction of the corrugations and the longitudinal axis of the pipe shall be approximately 90 degrees.

**4122.07 PERFORATIONS.** In all types of corrugated metal pipe underdrains the perforations shall be arranged in two groups of longitudinal rows placed symmetrically on either side of an unperforated segment corresponding to the flow line of the pipe. Within each group, the rows of perforations shall be spaced transversely approximately 1 inch, center to center, and in each row the perforations shall be located in the inside crests of all corrugations, except that perforations are not required within 4 inches of each end of each length of pipe or in the crests of corrugations where seams are located. The perforations shall have a diameter of not less than  $\frac{1}{4}$  inch and not more than  $\frac{3}{8}$  inch.

The minimum number of longitudinal rows of perforations and the minimum width of the unperforated segment shall be as specified in Table I. The center lines of the top or outer rows of holes shall be not more than  $67\frac{1}{2}$  degrees from the center line of the unperforated segment.

**4122.08 SPELTER COATING.** The finished pipe shall be coated on both sides with prime western spelter or equal at the rate of not less than 2 ounces per square foot of double exposed surface as specified in Section 4 of the Standard Specifications for Corrugated Metal Culvert Pipe, Designation M36, of the American Association of State Highway Officials, except that the spelter coating may be applied in accordance with one of the following alternate methods. Unless otherwise specified, either of these alternate methods will be acceptable.

**Alternate Method No. 1.** The pipe shall be galvanized after being fully fabricated and perforated.

**Alternate Method No. 2.** The pipe may be fabricated from galvanized sheets or strips and no further galvanizing will be required after fabrication or perforation if the spelter coating has not been injured in the fabricating process.

**4122.09 GAGE AND WEIGHT.** For corrugated metal pipe underdrains the gage of the metal shall be not less than that shown in Table I and the average weight per linear foot of finished pipe shall not underrun the weight given in Table I by more than 5 per cent.



**4122.10 COUPLING BANDS.** Field joints in corrugated metal pipe underdrains shall be made with galvanized band couplers of the same base metal as that used in the pipe. Band couplers shall have corrugations that mesh with the corrugations of the pipe. They shall be at least 7 inches in width and shall be of metal of the same gage number as the metal in the pipe.

If a one-piece band coupler is used, it shall be fastened with two  $\frac{3}{8}$ -inch diameter galvanized bolts; if a two-piece coupler is used, it shall be fastened with four  $\frac{3}{8}$ -inch diameter galvanized bolts. Other equally effective methods for connecting the sections may be used if approved by the Engineer.

**TABLE I—Dimensions and Weights of Pipe and Spacing of Longitudinal Rows of Perforations**

Nominal internal diameter	Galvanized sheet gage number	Weight per linear foot of pipe		Min. No. of rows of perforations	Min. width of unperforated segment
		Helically corrugated with lock seam or welded seam (Types I and II) and circumferentially corrugated with welded seam (Type III)	Circumferentially corrugated with riveted lap joints (Type IV)		
Inches		Pounds	Pounds		Inches
6	18	3.8	-----	4	4½
8	15	6.2	7.3	4	7
10	16	7.6	9.0	4	9
12	16	9.9	10.5	6	9½
15	16	12.4	12.9	6	13
18	16	14.8	15.3	6	16½
21	16	17.2	17.7	6	20

### Section 4123. Sectional Plate For Pipe and Arches

**4123.01 GENERAL.** Bolts and corrugated metal plates for use in construction of sectional pipe and arches shall comply with the requirements of A.A.S.H.O. Specification for Sectional Plate Pipe and Arches, Division IV, Section 19 of Standard Specifications for Highway Bridges (1944).



## Section 4124. Concrete Culvert Pipe

**4124.01 GENERAL REQUIREMENTS.** These specifications cover reinforced and non-reinforced concrete pipe intended to be used for the construction of culverts and storm sewers. Pipe furnished under these specifications shall be produced by a plant for which the method of manufacture and quality of product have been approved by the Commission prior to the date of award of contract.

The equipment and methods for controlling the proportions for the concrete, the forming and placing of reinforcement, the consolidation of the concrete in the molds, the protection and curing of the pipe, the molds, headers and pallets, shall be inspected and approved by the Engineer prior to beginning fabrication.

The Engineer shall be allowed at least seven days in which to pass upon methods and equipment after receiving written notice that preparations for the fabrication of the pipe have been completed.

No pipe shall be approved under these specifications unless that pipe or other pipe of the same size previously produced at the same plant has been fabricated under the inspection of the Engineer.

For preliminary approval of the product of any producing plant, the producer shall furnish for test purposes, at least five sections of each size of pipe, made on different days.

In case any test specimen fails to meet the specification requirements the producer shall furnish two additional test specimens for each section which failed.

Preliminary strength tests will be made only on pipe which has attained an age of 14 days, during which the average temperature of the air surrounding the pipe has been at least 60° F., or 28 days if the average temperature of the air surrounding the pipe has been less than 60° F.

The manufacturer shall furnish a testing frame conveniently located near the plant, built in accordance with plans furnished by the Iowa Highway Commission and approved by the Engineer.

**4124.02 CLASSIFICATION.** Concrete culvert pipe will be furnished in three classes according to their strength. These classes will be designated 1500D pipe, 2000D pipe, and 3000D pipe.



The three classes of pipe shall be indicated by the marks "15D," "20D," and "30D," and these class markings, also the date of manufacture and the trade mark shall be plainly marked or stenciled on the inside of the pipe near the tongue and not later than 24 hours after pipe are made. Any markings made by the use of paint shall be renewed before the original markings become unreadable.

**4124.03 STRENGTH.** When tested in accordance with the method herein specified, the strength of the pipe in pounds per foot of laying length shall not be less than shown in the following table:

Diameter of Pipe Inches	Minimum Strength of Pipe Pounds per Foot of Length — 3 Edge Bearing Method				
	Ultimate Load for Various Classes of Pipe			Load to produce 0.01 inch Crack in Concrete Pipe	
	3000D	2000D	1500D	3000D	2000D
12	3000	2000	1500	2700	1800
15	3750	2500	1875	2850	1900
18	4500	3000	2250	3000	2000
21	5250	3500	2625	3150	2100
24	6000	4000	3000	3300	2200
27	6750	4500	3375	3450	2300
30	7500	5000	3750	3750	2500
36	9000	6000	4500	4500	3000
42	10500	7000	5250	5250	3500
48	12000	8000	6000	6000	4000
54	13500	9000	6750	6750	4500
60	15000	10000	7500	7500	5000
66	16500	11000	8250	8250	5500
72	18000	12000	9000	9000	6000
84	21000	14000	10500	10500	7000

**4124.04 ABSORPTION.** The absorption determined in accordance with A.A.S.H.O. Method T33 shall not exceed 8 per cent of the dry weight.

**4124.05 LENGTH OF SECTIONS.** Unless otherwise provided in the contract documents, the length of pipe sections shall comply with the following: Pipe of the 2000D and 3000D classes in sizes 24 inches diameter and larger shall have a laying length of 6 feet. All other pipe shall have a laying length not less than 4 feet nor more than 6 feet.



**4124.06 MATERIALS.** Except for the particle size requirements for coarse aggregate, the materials used shall comply with the requirements of the following sections of these specifications. Coarse aggregate shall have particle sizes adapted to the dimensions of the pipe and the method of manufacture:

Portland Cement .....	Section 4102
Water .....	Section 4103
Fine Aggregate .....	Section 4104
Coarse Aggregate .....	Section 4107
Steel Reinforcement .....	Section 4131

**4124.07 CONCRETE MIXTURE.** The cement, aggregates, and water shall be so proportioned that the finished pipe will comply with the strength and absorption requirements of these specifications, but in no case shall the quantity of cement per cubic yard of concrete be less than 1.5 barrels.

**4124.08 DESIGN.** The details of thickness of shell, form and dimensions of end connections, the size and distribution of reinforcement shall conform to Standard Plan F-1 of the Iowa State Highway Commission.

**4124.09 MANUFACTURE.** The details of the manufacture of the pipe shall conform to the following requirements. The term Poured Pipe, as used herein, shall be construed to mean pipe manufactured by placing concrete of plastic consistency between forms and consolidated by vibration.

- A. **General Requirements.** The storage of cement, measuring of materials, mixing, the use of read-mixed concrete, placing of concrete in poured pipe, the protecting of concrete in cold weather, and the use of admixtures shall comply with the requirements of Section 2403.
- B. **Casting Base.** Forms for poured pipe shall rest on a clean, smooth, level concrete base at the time the concrete is placed.
- C. **Construction of Reinforcement Cages.** Welded wire fabric reinforcement cages shall be formed by a machine consisting of three rolls of which at least two shall be power driven. The rolls shall have diameters not less than  $\frac{3}{4}$  inch per foot of unsupported length, but not so



large as to render it inconvenient to form a cage of any required diameter. The machine shall be so constructed and operated as to produce cages accurately formed to the required shape and dimensions.

Reinforcement fabric that has become kinked from tight winding or other cause shall be discarded or straightened to the extent that a truly circular cage can be formed from it.

1. **Single Line Reinforcement.** Cages for single line reinforcement shall be so formed that wires in the laps of circumferential reinforcement are in the same plane parallel to the axis of the pipe. All laps of circumferential reinforcement shall be secured by welding. Laps having a length not less than 40 diameters of the wire may be secured by welding the circumferential wires to each of the wires parallel to the axis of the pipe within the limits of the lap. Such welds shall not reduce the strength of the circumferential wires below 70,000 pounds per square inch.

Circumferential laps not less than 4 inches long will be acceptable, provided the circumferential wires are welded together with a weld or welds that develop the strength of the wire and do not reduce the strength of the wire below 70,000 pounds per square inch.

2. **Double Line Reinforcement.** Cages for double line reinforcement shall be welded or securely tied to prevent spreading. Welds shall comply with the requirements for single line reinforcement. When cages are not welded the lap shall have a length not less than 40 diameters of the wire.

**D. Placing of Reinforcement.** The designed location of steel reinforcement is shown on Standard Plan F-1. The actual location of the steel in the pipe shall not vary from the design location by more than the following amounts for pipe of the wall thicknesses noted with the further requirement that at no point shall the coverage be less than  $\frac{3}{4}$  inch:



Wall Thickness Inches	Tolerance Inches	Wall Thickness Inches	Tolerance Inches
2	$\frac{1}{4}$	4	$\frac{1}{2}$
$2\frac{1}{4}$	$\frac{5}{16}$	$4\frac{1}{4}$	$\frac{9}{16}$
$2\frac{1}{2}$	$\frac{5}{8}$	$4\frac{1}{2}$	$\frac{5}{8}$
$2\frac{5}{8}$	$\frac{3}{8}$	$4\frac{5}{8}$	$\frac{5}{8}$
$2\frac{3}{4}$	$\frac{3}{8}$	5	$\frac{5}{8}$
3	$\frac{7}{16}$	$5\frac{1}{2}$	$\frac{11}{16}$
$3\frac{1}{4}$	$\frac{7}{16}$	6	$\frac{3}{4}$
$3\frac{5}{8}$	$\frac{7}{16}$	7	$\frac{13}{16}$
$3\frac{1}{2}$	$\frac{1}{2}$	8	$\frac{13}{16}$
$3\frac{3}{4}$	$\frac{1}{2}$		

Except as provided below, each plant manufacturing poured pipe shall be equipped with bolt cutters to which is attached a rigid gaging device for cutting transverse wires to such length that when bent at right angles to the axis of the pipe the ends of the wire will bear against the form when the reinforcement cage is in correct position. The gage shall be sufficiently accurate to insure that when the wires are bent by the method employed the cage so spaced will be within  $\frac{1}{16}$  inch of the design position. The gage shall be so designed that the tilting of the cutter will not materially affect the length of wire cut.

A chair or stirrup which can be rigidly attached to the circumferential wires and which is capable of spacing the cage within the above tolerance will be acceptable in lieu of the spacing method specified above.

A method appropriate to the action of the machine used shall be employed for holding the reinforcement cage in proper position in the case of pipe in which the concrete is consolidated by methods other than vibration.

The steel in pipe with a single line of reinforcement shall comply at all points with the above requirements as to position. The steel in pipe having two lines of reinforcement shall comply with the above requirements at all points except within the limits of laps. Within the limits of laps, if the wires lapped are not in the same plane parallel to the axis of the pipe the points midway between the two wires shall be within the above specified tolerance.



- E. **Forms.** Forms shall be smooth and true to shape and dimensions and be maintained in good condition.
- F. **Placing Concrete.** Concrete not consolidated during placement by a machine designed for that purpose shall be consolidated by vibration. External vibrators shall be so applied to the forms as to insure against causing the forms to be dented or deformed.
- G. **Curing.** The pipe shall be cured by one of the methods specified in A.A.S.H.O. M41, or by the application of a light colored liquid curing compound complying with the requirements of Section 4147 immediately after the forms are removed. The rate of application shall be not less than one gallon per 135 square feet.
- H. **Yarding.** Lines of pipe in storage yards shall be placed at least two feet apart with both ends of each pipe readily accessible to facilitate inspection.

**4124.10 METHODS OF TEST.** The load required to produce 0.01 inch crack and the ultimate load shall be determined by the 3 edge bearing method in accordance with the method prescribed in A.S.T.M. C76, except that the spacing of the bearing strips shall comply with the following:

The interior vertical sides of the strips shall be parallel and spaced a distance apart not less than 0.5 inch, nor more than 1.0 inch per foot of diameter of the pipe, but not less than 1.0 inch.

Tests for absorption shall be performed in accordance with the method prescribed in A.S.T.M. C76.

In order to determine the location of reinforcement within the pipe the Engineer may require not more than 16 holes or slots to be cut in the inner and the outer surfaces of each of a number of pipe not greater than the number of pipe which may be required to be tested for strength. The pipe furnished for this test may be in addition to those required for strength tests.

**4124.11 PERMISSIBLE VARIATIONS IN DIMENSIONS.** Variations from design dimensions shall not exceed the following limits:

- A. **Internal Diameter.** For pipe having nominal diameters 36 inches and less, plus or minus 1.0 per cent. For pipe having nominal diameters greater than 36 inches, plus or minus 0.75 per cent.



- B. **Shell Thickness.** For design thicknesses three inches and less, minus 7.0 per cent. For design thicknesses greater than three inches, minus 7.0 per cent or 0.21 inches, whichever is the greater.
- C. **Depth of Groove.** Plus or minus 4.0 per cent.
- D. **Length of Tongue.** Plus 0.0 per cent, minus 4.0 per cent.
- E. **Length of Section.** Minus 0.5 inch.
- F. **Straightness.** Pipe designed to be straight with ends perpendicular to the axis of the pipe shall comply with the following requirements. The plane of the ends of the pipe shall not deviate from the perpendicular to the axis of the pipe by more than  $\frac{1}{8}$  inch per foot. The walls of the pipe shall not deviate from a line parallel to the axis of the barrel by more than  $\frac{1}{2}$  inch per foot.

**4124.12 ACCEPTABILITY AND RETESTS.** Pipe shall be acceptable under the strength requirements when all the specimens tested comply with those requirements. A retest will be made only when one or the other or both of the following conditions exist:

- A. The pipe have attained greater age under conditions favorable to the increase in strength of concrete.
- B. The pipe have been carefully culled to remove pipe having obvious physical defects or construction defects known to the Inspector or the producer. Pipe so culled and retested shall be required to comply with the same requirements as apply to the original tests.

**4124.13 REJECTION.** Pipe shall be subject to rejection on account of failure to comply with any of the specification requirements or on account of any of the defects listed as causes for rejection in A. S. T. M. C76. Pipe which would otherwise be rejected may be accepted under any of the following conditions:

- A. **Strength.** Pipe which fail to meet the strength requirements for one grade may be accepted for any other grade with whose requirements their strength complies.
- B. **Wall Thickness.** Pipe which fail to meet the wall thickness requirements for one grade may be accepted for any other grade with whose requirements their wall thickness complies.



C. Placement of Reinforcement. Pipe which fail to meet the requirements as to placement of reinforcement steel, except for the minimum  $\frac{3}{4}$  inch coverage requirement, may be retested and accepted when all the following conditions are met:

1. None of the specimens in the original sample has failed to sustain loads at 0.01 inch crack and at ultimate less than 110 per cent of those specified.
2. At least three representative specimens of pipe have been prepared for test by carefully chipping away the concrete of both ends of the pipe to expose the steel, after which the specimens thus prepared are tested for strength with the pipe in such position that the misplacement of the steel will have the maximum effect in reducing the load carrying capacity of the pipe.
3. When tested as prescribed in the preceding paragraph all the specimens tested meet the specified strength requirements for the grade of pipe they represent.

### Section 4125. Cast Iron Culvert Pipe

4125.01 GENERAL. Cast iron culvert pipe shall conform to requirements of A.A.S.H.O. Specifications for Cast Iron Culvert Pipe M-64.

This type of pipe will not be used in 1500D strength class.

### Section 4126. Clay Culvert Pipe

4126.01 GENERAL. Clay culvert pipe shall conform to the requirements of the A.A.S.H.O. Specifications for Clay Pipe M-65, except that the strength by the 3 edge bearing method shall be designated in pounds per foot of laying length per foot of nominal pipe diameter. The pipe shall be furnished in two classes, designated 1500D Pipe and 2000D Pipe. Pipe shall conform to the strength requirements of Article 4124.03.

### Section 4127. Drain Tile

4127.01 GENERAL. Drain tile shall comply with the requirements of the A.S.T.M. Standard Specifications for drain tile Designation C-4. Unless extra quality drain tile are specified in the contract documents, standard drain tile shall be furnished.



## Section 4123. Sewer Pipe

**4123.01 DESCRIPTION.** This section includes the requirements for pipe to be used for sanitary sewers and for storm sewers.

**4123.02 PIPE FOR SANITARY SEWERS.** Pipe for sanitary sewers shall comply with the following requirements for the type of pipe specified in the contract documents:

- A. **Clay Sewer Pipe.** Clay pipe for sanitary sewers shall comply with the requirements of A.A.S.H.O. M65. Unless otherwise specified in the contract documents, standard clay pipe may be used.
- B. **Concrete Sewer Pipe.** Concrete sewer pipe shall comply with the requirements of A.A.S.H.O. M86.
- C. **Reinforced Concrete Sewer Pipe.** Reinforced concrete sewer pipe shall comply with the requirements of A.A.S.H.O. M87.

**4123.03 PIPE FOR STORM SEWERS.** Pipe for the construction of storm sewers shall comply with the requirements for one of the types of pipe specified in Article 4123.02 or with the requirements for concrete culvert pipe, Section 4124. Unless otherwise specified in the contract documents, concrete culvert pipe of the 1500D grade may be used.

## Section 4129. Brick

**4129.01 BUILDING BRICK.** All brick used in building shall be of the color and texture specified on the plans or in the contract documents. The grade of brick furnished shall conform to the following specifications for the uses specified:

Intended Use	Type	Grade	A.S.T.M.
			Specifications
Exterior Walls	Clay or shale	SW	C-62
Interior Walls	Clay or shale	MW	C-62
Interior Walls	Concrete	A	C-55

**4129.02 PAVING BRICK.** Brick used for pavement wearing surface shall be lug brick of the type and thickness specified in the contract documents.

The brick shall conform to the requirements of the A.S.T.M. specification for paving brick C-7, with the additional pro-



vision that the rattler loss shall be determined for individual brick and shall not be more than the following:

Thickness of Brick	Maximum Per Cent Rattler Loss for Individual Brick
2 $\frac{1}{2}$	30
3	28
3 $\frac{1}{2}$	26

The loss for individual brick shall be obtained by comparing the weight of individual brick after testing with the average weight of brick in that sample before testing.

**4129.03 SEWER BRICK.** Brick to be used in construction of manholes, catch basins and other sewer installations shall conform to one of the following types:

- A. Brick meeting requirements of A.S.T.M. specifications for sewer brick C32 grade M A with saturation coefficient not greater than 0.8.
- B. Brick meeting the A.S.T.M. specifications for building brick C-62 grade S W.
- C. New paving brick conforming with requirements of Article 4129.02.
- D. Paving brick salvaged from old pavement may be accepted in lieu of new brick, provided they are properly cleaned and sound, and comply with the requirements for new brick.

### Section 4130. Guard Rail Cable and Fittings

**4130.01 GENERAL.** Cable and fittings for guard rail construction shall conform to the following requirements for size and class of cable specified in the contract documents.

**4130.02 WIRE ROPE.** Wire rope for guard rail shall conform to the requirements of A.A.S.H.O. Specification M-30. Unless otherwise specified, Class B rope shall be furnished.

**4130.03 FITTINGS.** All guard rail fittings shall be of the type specified in the contract documents. In all cases where stress is transmitted through eyebolts, clips, turnbuckles, spring takeups, or other fittings, the minimum tensile strength of such connections when assembled shall be at least equal to the strength of the size and class of cable or cables specified.

The actual weight of all guard rail fittings shall be within



5 per cent of the theoretical weight for the nominal dimensions specified on the plans.

Fittings shall have a smooth and continuous coating of zinc applied by the hot dip process. The coating shall be strongly adherent, shall be free from blisters, scales, holes or other imperfections. The rate of coating on all surfaces, except female threads, shall not be less than 1.0 ounce per square foot.

Weight of coating shall be determined by A.S.T.M. Standard Method for determining weight of coating on zinc coated articles, A-90.

### Section 4131. Steel Reinforcement

4131.01 **GENERAL.** Steel for the reinforcement of concrete shall be of the size and type specified in the contract documents, and shall comply with the following requirements for the type and use so specified:

4131.02 **BAR REINFORCEMENT.** Bar reinforcement shall comply with the following requirements:

A. **Bar Reinforcement for Pavement.** Bars used for reinforcement of pavement shall be plain or deformed bars of the size specified, conforming with requirements for hard grade bars or rail steel bars of the following A.S.T.M. Specifications, except as outlined herein:

Billet Steel Bars for Concrete Reinforcement .....A-15

Rail Steel Concrete Reinforcement Bars .....A-16

Axle Steel Bars for Concrete Reinforcement .....A-160

1. Bars used as dowels across expansion joints shall be plain bars. The transverse bars to which the dowel bars are welded may be structural grade.

2. Bars used as tie-dowels between adjacent slabs where bars must be bent in installation and later straightened, shall be structural grade deformed bars, either billet steel or axle steel.

B. **Bar Reinforcement for Structures.** Bars used for reinforcement of structures shall be deformed bars of intermediate grade of the size specified, conforming to the requirements of either of the following A.S.T.M. Specifications:

Billet Steel Bars for Concrete Reinforcement .....A-15

Axle Steel Bars for Concrete Reinforcement .....A-160



C. Deformations. The form of deformation shall be of a design approved by the Engineer.

**4131.03 WIRE MESH REINFORCEMENT.** Wire mesh used as reinforcement for concrete shall be electrically welded rectangular mesh. The size and spacing of wires and weight per 100 sq. ft. shall conform to the requirements shown on the plans. Wire mesh shall conform to the requirements of the A.A.S.H.O. Specification for "Welded Wire Fabric for Concrete Reinforcement" M-55.

### Section 4132. Structural Steel

**4132.01 GENERAL.** Except when alloy steels are specified, all steel for plates, rolled shapes or bars for steel structures shall be furnished in structural carbon steel. The various types of steel shall conform to the requirements of the following specifications for the respective types:

**4132.02 STRUCTURAL CARBON STEEL.** Structural carbon steel shall conform to A.A.S.H.O. Specification for "Steel for Bridges and Buildings" M-94.

### Section 4133. Rivet Steel

**4133.01 GENERAL.** When structural carbon steel is used in steel structures the rivets used in conjunction with such steel shall conform to the requirements of the A.A.S.H.O. Specification for "Structural Rivet Steel" M-97.

### Section 4134. Miscellaneous Iron and Steel

**4134.01 STEEL FORGINGS.** Forgings from which pins, rollers, trunnions, or other forged parts are made, shall conform to the requirements of A.A.S.H.O. Specification for "Carbon Steel Forgings for Industrial Use" M-102. Class C-1 forgings shall be used for fabrication of pins, rollers, or trunnions, having a diameter of 6 inches or more.

**4134.02 COLD FINISHED STEEL.** Pins and rollers having a diameter less than 6 inches shall be made from cold finished steel conforming with A.S.T.M. Specification for "Cold Finished Bar Steels and Cold Finished Shafting" A-108.

**4134.03 STEEL CASTINGS.** Steel castings shall conform to the requirements of A.A.S.H.O. Specifications for "Carbon



Steel Castings for Miscellaneous Industrial Uses," M-103, Grade B-1, supplemented by the following provisions:

- A. **Workmanship.** Steel castings shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended.
- B. **Blow Holes.** The finished castings shall show no blow holes exceeding  $\frac{1}{2}$  square inch in area or one inch in length, and the total length of cavity cut by a straight line laid in any direction shall not exceed one inch in one foot.
- C. **Defects.** 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.
- D. **Unfilleted Corners.** Steel castings shall be free from unfilleted angles or corners.

**4134.04 IRON CASTINGS.** Iron castings shall conform to the requirements of A.A.S.H.O. Specification for "Gray Iron Castings" M-105, supplemented by the following: Class 30 shall be used unless otherwise specified in the contract documents.

Castings shall be boldly filleted at angles and the arises shall be sharp and perfect. Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes or other defects in positions affecting their strength for service intended. With the approval of the Engineer, minor defects which do not impair the strength of castings may be welded by an approved process. Castings which have been welded without the permission of the Engineer shall be rejected. The frames and grates for drainage openings shall be straight and shall fit properly together so that traffic will not cause them to rattle. Rough spots which prevent suitable fitting may be removed by grinding.

**4134.05 WROUGHT IRON.** All wrought iron plates shall conform to the requirements of A.A.S.H.O. Specification for "Wrought Iron Plates" M-99 for Standard Plate. All wrought iron shapes or bars shall conform to the requirements of A.A.S.H.O. Specifications for "Wrought Iron Shapes or Bars" M-100.



**4134.06 WELDED STEEL AND WROUGHT IRON PIPE.**

Unless otherwise specified, all welded steel or wrought iron pipe shall be standard weight black pipe conforming to the requirements for the respective type of pipe in A.A.S.H.O. Specifications for Welded Wrought Iron Pipe, M-101, or A.S.T.M. Specifications for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, A-120.

**Section 4135. Paints**

**4135.01 GENERAL REQUIREMENTS.** Paint shall consist of pigments of the specified composition ground to the required fineness in the specified vehicles, to which shall be added thinner and drier, as may be required in the specifications for each kind of paint. The fineness of the grinding shall be such that when the pigment extracted from a representative sample of the paint is washed with gasoline through a No. 325 sieve until no trace of pigment is evidenced in the washings, not more than 3 per cent of the total weight of the sample shall be retained on the sieve. The paint shall conform in color to the sample furnished by the Commission. The brushing consistency shall be such that when the paint is applied to a smooth and clean vertical steel surface there shall be no running, streaking or sagging of the paint during the time required to dry.

When paints other than aluminum and black paint for guard rails are brushed on a clean, dry metal panel at a rate of 500-550 square feet per gallon the paints shall dry firm and hard in less than 18 hours.

**4135.02 VEHICLE.** The vehicle of the various paints shall consist of linseed oil or varnish of the quality specified, with drier and thinner required to give the paint the desired drying qualities. The vehicle shall not contain more than 0.5 per cent of water. The components of the vehicle shall conform to the following requirements for the respective materials:

- |   |              |
|---|--------------|
| A. Raw Linseed Oil A.S.T.M. Specifications....  | D234         |
| B. Boiled Linseed Oil A.S.T.M. Specification....  | D260         |
| C. Liquid Drier, A.S.T.M. Specification.....  | D600 Class B |
| D. Mineral Spirits A.S.T.M. Specification.....  | D235         |
| E. Polymerized Linseed Oil. The linseed oil shall be bodied by low temperature cooking at atmospheric pressure to produce the de- |              |



sired consistency. It shall conform to the following requirements for the consistency of oil specified:

	Q Viscosity	Z <sub>4</sub> Viscosity
1. Color on the Hellige Comparator shall not be darker than .....	No. 5	No. 5
2. Acid Number.....Not more than .....	8.0	14.0
3. Iodine Number (Wijs) Not less than .....	140.0	115.0
4. Saponification No. not less than .....	190.00	190.0
5. Specific Gravity at 60° F....	0.948 to 0.952	.960 to .973
6. Viscosity (Gardner-Holdt Scale at 77° F.) .....	Q	Z <sub>4</sub>

#### F. Spar Varnish for Aluminum Paint.

This specification is designed to procure a 50-gallon length, 100 per cent phenolic or alkyd resin varnish complying with the following requirements:

1. **Composition.** The total solids in the varnish shall not be less than 55.0 per cent.
2. **Viscosity.** The varnish shall have a viscosity of "B" to "D" on the Gardner-Holdt scale at 77° F.
3. **Kauri Reduction.** The varnish shall pass a 140 per cent Kauri reduction test at 77° F.
4. **Skimming.** The varnish shall show no skinning after 48 hours in three-quarter filled tightly closed containers.
5. **Color.** The color shall not be darker than nine on the paint and varnish Hellige Comparator.
6. **Appearance.** The varnish shall be clear, homogeneous, and free from suspended matter.
7. **Water Resistance.** A flow out film on a tin plated panel, dried for 48 hours shall withstand immersion in water at room temperature for 24 hours without whitening or dulling.
8. **Performance.** When combined with paste aluminum in accordance with provisions of Paragraph 4135.04F the resulting paint shall show the characteristics specified.



G. Alkyd Varnish. This specification is designed to produce an alkyd varnish free from rosin and rosin derivatives. The varnish shall be of the alkyd phthalate type. The total solids by weight shall not be less than 50 per cent. The solids shall be composed of not less than 28.0 per cent phthalic anhydride and 50.0 to 60.0 per cent soya bean or linseed oil or a combination of the two. The varnish shall be clear, transparent and homogeneous and conform to the following requirements:

1. Acid Number. The acid number of the varnish solids shall not be greater than 6.0.
2. Viscosity. The varnish shall show viscosity V to Y on the Gardner-Holdt scale at 77° F.
3. Color. The color shall not be darker than 9 on the paint and varnish Hellige Comparator.
4. Drying Time. The drying time shall be adjusted to meet the drying time requirement for the paint in which it is to be used.
5. Water Resistance. A flow out film on a tin plated panel dried for 48 hours shall be immersed in a beaker of water for 3 hours. The panel, wiped carefully and allowed to dry at room temperature. Any whitening or dulling shall disappear completely within 30 minutes after the panel is wiped dry.
6. Compatability. When ground with the pigments specified for the paint, the varnish shall show no appreciable thickening or livering after standing 48 hours in a  $\frac{3}{4}$  filled tightly closed container at 100° F. The varnish shall be miscible with mineral spirits in all proportions.

H. Turpentine. A.S.T.M. Specification D-13.

4135.03 PIGMENTS. Except for aluminum, pigments used in the manufacture of paint shall be in the dry form. The respective pigments shall conform to the following requirements:

- |  |      |
|--|------|
| A. Aluminum Pigment Paste, Type A                    |      |
| A.S.T.M. Specification .....                         | D474 |
| B. Black Synthetic Iron Oxide                        |      |
| A.S.T.M. Specification .....                         | D769 |
| C. Chromic Oxide Green A.S.T.M. Specifications ..... | D263 |
| D. Lampblack A.S.T.M. Specification .....            | D209 |
| E. Zinc Chromate A.S.T.M. Specification .....        | D478 |



- F. Red Iron Oxide A.S.T.M. Specification .....D84  
 Class II except that the total iron oxide calculated  
 as  $Fe_2O_3$  shall not be less than 80.0 per cent.
- G. Magnesium Silicate A.S.T.M. Specification .....D605
- H. Red Lead (97% Grade) A.S.T.M. Specification .....D83
- I. Titanium Dioxide (Non-Chalking Type)  
 A.S.T.M. Specification .....D476
- J. Zinc Oxide (Acicular Type) A.S.T.M. Specification.....D79
- K. Silica, Silica pigment shall be not less than 99.5 per  
 cent pure Silicon Dioxide ( $SiO_2$ ) meeting the ap-  
 proval of the Engineer.

**4135.04 PAINT COMPOSITION.** Paints shall be composed  
 of pigments and vehicles conforming to the requirements of  
 Articles 4135.02 and 4135.03 and shall conform to the following  
 requirements for the respective type of paints:

**A. White Paint.** White paint shall be of Titanium Dioxide  
 Zinc Oxide type conforming to the following require-  
 ments:

**1. Paint Composition.**

Pigment .....	not less than 52.0%
Vehicle .....	not more than 48.0%
Weight per gallon at 77° F. ....	not less than 12.0 lbs.

**2. Pigment Composition.**

Titanium dioxide (Non-chalking Type) .....	23.0%
Magnesium silicate .....	32.0%
Zinc Oxide (Acicular Type) .....	34.0%
Silica .....	11.0%

**3. Vehicle Composition.**

Raw linseed oil .....	40.0%
Polymerized linseed oil, $Z_4$ Viscosity .....	25.0%
Drier and mineral spirits .....	35.0%

**4. Primer Coat.** For the first coat of paint applied to  
 wood the paint may be thinned by adding to one  
 gallon of paint conforming to the foregoing require-  
 ments, 1 pint of turpentine or mineral spirits. For all  
 subsequent coats or on other surfaces the paint shall  
 not be thinned.

**B. Zinc Chromate Shop Coat.** Zinc chromate paint for shop  
 coat on structural steel shall be zinc chromate-iron oxide  
 paint conforming to the following requirements:



## 1. Paint Composition.

Pigment .....	not less than 45.0%
Vehicle .....	not more than 55.0%
Weight per gallon, at 77° F., .....	not less than 11.0 lbs.

## 2. Pigment Composition.

Zinc Chromate .....	50.0%
Iron Oxide .....	25.0%
Magnesium Silicate .....	25.0%

## 3. Vehicle Composition.

Alkyd Varnish .....	70.0%
Raw Linseed Oil .....	12.0%
Thinner and Drier .....	18.0%

C. Red Lead Paint for Shop Coat. Red lead paint for shop coat on structural steel shall be Red Lead Paint conforming with the following requirements:

## 1. Paint Composition.

Pigment .....	not less than 79.0%
Vehicle .....	not more than 21.0%
Weight per gallon at 77° F. ....	not less than 25.4 lbs.

## 2. Pigment Composition.

Red Lead (97% Grade) .....	100.0%
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To each 100 pounds of pigment there shall be added 0.25 lb. of aluminum stearate either dry or gelled in mineral spirits.

## 3. Vehicle Composition.

Raw linseed oil .....	40.0%
Polymerized linseed oil, Q Viscosity .....	25.0%
Mineral Spirits .....	30.0%
Drier .....	5.0%

Mineral spirits added with aluminum stearate gel shall be figured as part of the vehicle.

D. Zinc Chromate Paint for First Field Coat. Zinc chromate paint for first field coat on structural steel shall be zinc chromate-iron oxide paint conforming to the following requirements:

## 1. Paint Composition.

Pigment .....	not less than 45.0%
Vehicle .....	not more than 55.0%
Weight per gallon, at 77° F. ....	not less than 11.0 lbs.



## 2. Pigment Composition.

Zinc Chromate .....	50.0%
Iron Oxide .....	24.7%
Lampblack .....	0.3%
Magnesium Silicate .....	25.0%

## 3. Vehicle Composition.

Alkyd Varnish .....	70.0%
Raw Linseed Oil .....	12.0%
Thinner and Drier .....	18.0%

E. Red Lead for First Field Coat. Red lead paint for First Field Coat shall be Red Lead Paint conforming with the following requirements:

## 1. Paint Composition.

Pigment .....	not less than 79.0%
Vehicle .....	not more than 21.0%
Weight per gallon at 77° F. ....	not less than 25.3 lbs.

## 2. Pigment Composition.

Red Lead (97% Grade) .....	99.8%
Lampblack .....	0.2%

To each 100 pounds of pigment there shall be added 0.25 lb. of aluminum stearate either dry or gelled in mineral spirits.

## 3. Vehicle Composition.

Raw linseed oil .....	40.0%
Polymerized Linseed Oil, Q Viscosity .....	25.0%
Mineral spirits .....	30.0%
Drier .....	5.0%

Mineral spirits added with aluminum stearate gel shall be figured as part of the vehicle.

F. Aluminum Paint. Aluminum paint shall be made by mixing one and three-fourths ( $1\frac{3}{4}$ ) pounds of the specified paste aluminum pigment with one gallon of the specified vehicle. The paint shall have good leafing qualities, show satisfactory brushing and leveling qualities and shall not break or sag when applied to a smooth vertical steel surface. The paste pigment and vehicle shall be mixed together at the site of the work.

When brushed on a metal panel at a rate of 650-800 square feet per gallon it shall dry firm and hard in less than 12 hours.



G. **Black Paint for Bridges.** Black Paint for final field coat on steel structures shall conform to the following:

1. **Paint Composition.**

Pigment .....	not less than 35.0%
Vehicle .....	not more than 65.0%
Weight per gallon at 77° F. ....	not less than 10.0 lbs.

2. **Pigment Composition.**

Black synthetic iron oxide .....	80.0%
Lampblack .....	5.0%
Magnesium silicate .....	15.0%

3. **Vehicle Composition.**

Boiled linseed oil .....	40.0%
Polymerized Linseed Oil, Z <sub>4</sub> Viscosity .....	25.0%
Drier and mineral spirits .....	35.0%

H. **Chrome Green Paint.** Chrome green paint for the final field coat on steel structures shall conform to the following:

1. **Paint Composition.**

Pigment .....	not less than 50.0%
Vehicle .....	not more than 50.0%
Weight per gallon at 77° F. ....	not less than 12.0 lbs.

2. **Pigment Composition.**

Chromic Oxide green .....	45.0%
Black synthetic iron oxide .....	45.0%
Magnesium silicate .....	5.0%
Silica .....	5.0%

3. **Vehicle Composition.**

Boiled linseed oil .....	40.0%
Polymerized linseed oil, Z <sub>4</sub> Viscosity .....	25.0%
Thinner and Drier .....	35.0%

I. **Black Paint for Guard Rail Posts.** Black paint to be used for the lower portion of wood guard rail posts shall be a tar paint. It shall be a mixture of tar pitch and oils which are closely fractionated light tar distillates. The character of the pitch shall be such that the finished paint will remain homogeneous and free from settlement of coke like material. The paint shall conform to the following requirements:



1. When tested in a Saybolt Viscosimeter the paint shall show a Furol Viscosity of 45 to 60 seconds at 77°F.
2. When subjected to the distillation test according to A.S.T.M. Standard Method D-20 the paint shall show a total distillate to 300° C. of 25 to 50 per cent.
3. The amount of water in the paint shall not exceed 1 per cent.
4. When brushed on a glass plate at a rate of 300 to 400 square feet per gallon the paint film shall set to touch within 30 minutes.
5. The color of the paint shall be a dense, lustrous black.
6. The softening point of the tar pitch used in the manufacture of the paint shall not exceed 160° F. when tested by the cube-in-water method (A.S.T.M. Standard Method D-61).

**4135.05 PACKAGES AND MARKING.** Paint shall be packaged in strong, substantial containers, plainly marked with the color, type, and volume in gallons of the paint content, the lot identification number and the name and address of the manufacturer. Unless otherwise specified, paint shall be packaged in 5-gallon containers.

Aluminum paint shall be packaged in 5-gallon containers with separate compartments for 7.65 pounds of paste and 4.37 gallons of vehicle.

**4135.06 INSPECTION.** Unless otherwise specified in the contract, the County reserves the right to inspect all paint as delivered. In case the County elects to inspect paint at the factory, the Engineer or his representative shall have free access to the plant for inspection purposes, and every facility shall be extended to him for this purpose.

**4135.07 SAMPLES FOR TEST.** Where factory inspection is to be made, before the paint is made the manufacturer shall submit, upon request, samples of each of the ingredients of the paints he proposes to furnish, in the amounts specified. These samples shall constitute the standards of comparison for any material supplied.

Samples required for testing purposes shall not be less than the amounts hereinafter specified. Ready mixed paints shall be mixed carefully by very thorough stirring before samples



are taken. All samples shall be shipped in clean, tin containers with tight-fitting covers and so packed that no damage will result during transit. They shall be properly labeled and each sample shall be accompanied by a card or tag, securely attached, giving full information relative to the sample.

#### Quantities of Samples Required

Ready mixed paints or enamel .....	not less than 1 pint
Linseed oil and varnish .....	1 quart
Thinner and drier .....	not less than 1 pint
Pigments (Paste or dry) .....	$\frac{1}{4}$ pound

**4135.08 METHODS OF TESTING.** In testing paint to be used under these specifications, the Standard and Tentative Standard Methods of the A.S.T.M. shall be used when applicable.

All percentages are stated on a weight basis. If upon analysis the composition of pigment and vehicle is found to be within 1.0 per cent of the specified percentages the material will be considered to have complied with these requirements.

Drying time will be tested at an atmospheric temperature of 70° to 80° F., a relative humidity of 45 to 65 per cent and with the specified spreading rate.

### Section 4136. Wood Preservatives

**4136.01 CREOSOTE OIL.** Creosote oil for wood preservative shall be a distillate of coal-gas tar or coke-oven tar, complying with the following additional requirements:

	Min.	Max.
A. Water per cent by volume .....		3.0
B. Matter insoluble in Benzol, per cent by weight		
New oil .....		0.5
Used oil .....		1.0
C. Specific gravity of creosote at 38°C. compared to water at 15.5° C. ....	1.03	
D. Total distillate on water free basis shall be within the following limits:		
Per cent by weight		
Up to 210° C. ....		5.0
Up to 235° C. ....		25.0
Up to 355° C. ....	65.0	



E. Coke residue, per cent by weight	
New oil .....	2.0
Used oil .....	2.5
F. Tar Acids, per cent by weight in fraction distilling between 235 and 315°C. ....	
	1.0

4136.02 **CREOSOTE-COAL TAR SOLUTION.** The oil shall be a pure coal tar product. It may be either a coal tar distillate oil or a solution of coal tar in distillate oil. It shall comply with the following requirements:

	Min.	Max.
A. Coal tar distillate, per cent by volume .....	80.0	-----
B. Water, per cent by volume .....	-----	3.0
C. Material insoluble in Benzol, per cent by weight		
New oil .....	-----	2.0
Used oil .....	-----	3.0
D. Coke residue, per cent by weight		
New oil .....	-----	5.0
Used oil .....	-----	6.0
E. Specific gravity at 38°C. compared to water at 15.5° C. ....		
	1.06	1.11
F. Total distillate per cent by weight on water free basis shall be within the following limits:		
Up to 210° C. ....	-----	5.0
Up to 235° C. ....	5.0	25.0
Up to 315° C. ....	36.0	-----
Up to 355° C. ....	60.0	-----
G. Tar Acids, per cent by weight in fraction dis- tilling between 235 and 315° C. ....		
	1.0	-----

### Section 4137. Preservative Treatment

4137.01 **GENERAL.** Timber, lumber, piling and posts to be treated shall be given preservative treatment in accordance with the following provisions. Unless otherwise specified, materials shall be given pressure treatment with creosote oil by the empty cell process with initial air pressure.

4137.02 **PRESSURE TREATMENT.** Pressure treatment with creosote oil shall be performed in accordance with the following provisions:



- A. **Plant Equipment.** Treating plants shall be equipped with thermometers and gauges necessary to indicate and record accurately the conditions at all stages of treatment. All equipment shall be maintained in acceptable, proper working condition.
- B. **Preparation of Material.** Insofar as practicable, all trimming, boring, framing of material to be treated shall be performed before treatment. Douglas fir timbers and lumber over three inches thick by five inches and wider in lengths of six feet or over, shall be incised on all four faces before treatment. Douglas fir material three inches in thickness, in lengths six feet or over will be incised on wide faces only. The pattern of incision shall consist of successive parallel rows of punctures spaced not over one inch apart across the face of the piece, with not more than  $2\frac{1}{2}$  inches between rows. The punctures shall be staggered so that in three successive rows two punctures will be spaced between each two punctures of the first row. The depth of incisions shall be such that a uniform penetration of the preservative is secured in accordance with the depth of penetration specified in paragraph G. The form of knife shall be such as will separate rather than cut the wood fibers.
- C. **Sorting and Spacing.** Materials to be treated shall be grouped so that each charge is composed of material of similar moisture and sapwood content and equally susceptible to treatment. When the quantity of any one size of timber to be treated is insufficient to constitute a full charge, mixed sizes may be treated. Piling and round posts shall not be treated with sawn timber. Pieces shall be separated sufficiently to insure contact of the heating medium and preservative with all surfaces.
- D. **Conditioning Douglas Fir.** Douglas fir shall be conditioned by heating in the oil with which the material is to be treated. The oil shall completely cover the material in the cylinder. The temperature of the oil during the conditioning period shall not exceed  $210^{\circ}$  F. Vacuum shall be drawn of sufficient intensity to evaporate water from the material at the temperature of the oil. The intensity of vacuum and temperature of the oil shall be adjusted to regulate the evaporation of water satisfactorily. The conditioning of the material shall continue



until enough water is removed to permit proper penetration.

The oil shall be removed from the cylinder before an empty cell process is applied.

**E. Conditioning Southern Pine.** Southern Pine may be conditioned by heating in oil as specified in paragraph D for fir or it may be air-seasoned before treatment or steam-seasoned in the cylinder. When material is air-seasoned it shall be given the full specified amount of treatment before it shows any evidence of incipient decay or deterioration from seasoning. When Southern Pine is steam seasoned it shall be steamed in the cylinder at a temperature not more than 259° F. (approximately 20 pounds pressure) for not more than 18 hours. The maximum temperature shall not be reached in less than one hour. The cylinder shall be provided with vents for removal of air and to insure proper distribution of steam. The duration of steaming shall be based on consideration of moisture condition and cross section of pieces in the charge. After steaming is completed the cylinder shall be subjected to sub-atmospheric pressure of less than 8 inches of mercury maintained for not less than 30 minutes. The cylinder shall be relieved continuously enough to prevent condensate from accumulating in quantity sufficient to reach the wood. Before the preservative is introduced the cylinder shall be drained of condensate.

**F. Preservative.** Unless otherwise specified, the preservative used shall be creosote oil conforming with requirements of Article 4136.01.

**G. Penetration.** The range and duration of temperature and pressure shall be so controlled as to result in the maximum penetration with the quantity of preservative injected. The penetration of the preservative shall be not less than shown in the third and fourth columns of the following table, or that computed from the formula following the table:



Species	Material	Specified Amount of Preservative, Pounds Per Cubic Foot	
		Less than 12	12 or more
Douglas Fir	Piling or Round Posts	.875 inches	1.0 inches
	Timber 12x12 and larger	.65 inches	.75 inches
Southern Pine	Piling and Round Posts	3 inches but not less than 90% of sapwood thickness	3.5 inches but not less than 90% of sapwood thickness
	Sawn Timber	All sapwood and as much heartwood as possible.	

For Douglas Fir timbers having ratios of volume to superficial area less than that of a timber 12x12 inches the required minimum depth of penetration shall be determined by the following formula, but in no case shall be less than  $\frac{3}{8}$  inch or less than 90 per cent of the thickness of sapwood.

$$P = \frac{P_s \times R}{R_s}$$

Where P=Required penetration

$P_s$ =Specified penetration in 12x12 inch timbers

$R_s$ =Ratio of volume of 12x12 to its superficial area

R=Ratio of volume of piece in question to its superficial area.

H. **Determination of Penetration.** The penetration of the preservative shall be based on the black or dark oil and in no case will light discoloration of the wood, due to treatment, be taken into consideration in measuring the depth of penetration. The depth of penetration will be determined by increment borings from a sufficient number of pieces to be representative of each charge, but not less than five borings from each tram load. All such holes shall be plugged with tight fitting treated plugs.

I. **Empty Cell Process.** The charge shall be subjected to air pressure of 25 to 50 pounds and this pressure maintained while the cylinder is being filled with preservative. The pressure shall then be raised to not more than 150 pounds per square inch. The charge shall then be held under pressure until there is obtained the largest volumetric injection that can be reduced to the stipulated retention with a quick high vacuum. The temperature of the preservative during the entire pressure period shall not be more than 210° F., but shall average



at least 180° F. After pressure is completed the cylinder shall be emptied speedily of the preservative and the cylinder subjected to subatmospheric pressure of less than 8 inches of mercury, which shall be maintained until the wood can be removed from the cylinder free from dripping creosote. The volume of the charge shall be computed from the nominal dimensions of rough material and from the actual surfaced dimensions of surfaced material with no allowance for reduction in size due to boring or framing.

- J. **Amount of Preservative.** The amount of water-free oil retained in the wood shall not be less than the sum obtained by multiplying the volume of wood in pieces of each size in the charge by the final retention specified in the following table and adding together the results obtained:

Pieces Composing the Charge	Amount of Preservative per Cubic Foot
Timber with nominal thickness under 5" .....	12 lb.
Timber with nominal thickness 5" to 9" .....	10 lb.
Timber with nominal thickness 10" or over .....	8 lb.
Piling .....	12 lb.
Posts .....	8 lb.
Material for laminated wood culverts* ..	10 lb.
Material for laminated bridge floors* .....	8 lb.

\*These materials shall not be treated in mixed charges requiring different amounts of oil.

- K. **Special Treatment for Guard Rail and Sign Posts.** Sign and guard rail posts which have been given preservative treatment with creosote oil, before being removed from the cylinder shall be further subjected to live steam at a maximum pressure of 20 pounds and following that to an additional period of vacuum to insure that the surface of the wood is free from accumulation of tarry material.

**4137.03 NON-PRESSURE TREATMENT.** Posts or poles to be given preservative treatments on the butts only shall be treated in accordance with following provisions:

- A. **Seasoning.** All pieces to be given non-pressure preservative treatment shall be thoroughly air seasoned before treatment and shall be treated before they show any evidence of incipient decay.



- B. **Shaving.** Poles shall be shaved over the butt so that all the inner bark is removed from the surface for the length to be set in the ground, plus 18 inches. Posts for guard rail, guard posts or flume posts shall be shaved for their full length so that all inner bark and all wood glazed by dried sap is removed. Only a minimum amount of wood shall be removed in shaving.
- C. **Preservative.** The preservative shall be creosote oil complying with requirements of Article 4136.01.
- D. **Plant Equipment.** The plant shall be equipped with thermometers necessary to indicate and record accurately the temperature at all stages of the treatment. This equipment shall be maintained in good working order.
- E. **Treatment.** The treatment shall consist of two periods: first the hot bath, second the cold or cooling bath.
1. **Hot Bath.** The portions of posts and poles for which treatment is specified shall be continuously immersed in the preservative at a temperature of  $230^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ , for not less than 6 hours and such additional period as will insure maximum penetration of the preservative.
  2. **Cold or Cooling Bath.** The preservative of the hot bath may be allowed to cool gradually or may be replaced with cold preservative provided the exchange is completed within 10 minutes. When the preservative of the hot bath is replaced by cold preservative, the posts and poles shall be continuously immersed in the cold bath for a period of not less than two hours, and the temperature of the preservative for the entire period shall be between  $150^{\circ}\text{F.}$ , and the temperature at which solids form in the preservative.

When the preservative of the hot bath is allowed to cool gradually, the posts and poles shall be continuously immersed in the cooling bath at least two hours and until the temperature of the preservative has been reduced to a point between  $150^{\circ}\text{F.}$  and the temperature at which solids form in the preservative. They shall then remain in the bath at this temperature for not less than 10 minutes.

The depth of the preservative in the hot, cold, or cooling baths shall be maintained at such level as to completely cover the surface to 1 foot greater than the



depth to which the posts or poles are to be set in the ground as shown by the standard plans.

F. Storage. After treatment the posts or poles shall be stored in such manner that the untreated portion will be kept free from creosote oil.

### Section 4138. Untreated Timbers and Lumber

**4138.01 GENERAL REQUIREMENTS.** All rough and dressed timbers and lumber furnished under these specifications shall be new and unused material and shall conform to the following detailed requirements as to size and quality for the grade called for in the contract documents.

The Contractor's attention is directed to provisions of Article 4101.05 for inspection requirements.

**4138.02 LENGTHS OF MATERIAL.** The lengths of all materials furnished under these specifications shall be in multiples of 2 feet unless otherwise specified in the contract documents.

**4138.03 MINIMUM ACCEPTABLE SIZES.** All material furnished shall conform to the dimensions specified for either "Rough", "Surfaced" or "Surfaced Hit or Miss" stock. Unless otherwise specified on the plans or in the contract documents rough material shall be furnished. Materials covered by these specifications are classified as follows according to use:

**Joist and Plank:**

Nominal thickness.....	2 in., 3 in., and 4 in.
Nominal widths.....	4 in. and wider in multiples of 2 in.
Dressed thickness,	
S1S or S2S.....	3/8 in. off
Dressed widths,	
4 and 6 in., S1E or S2E.....	3/8 in. off
8 in. and wider S1E or S2E.....	1/2 in. off

**Beams and Stringers:**

Nominal thickness.....	5 in. and thicker
Nominal widths.....	8 in. and wider in multiples of 2 in.
Dressed sizes,	
S1S, S1E, S2S or S4S.....	1/2 inch off



**Posts and Timbers:**

Nominal sizes..... 6 in. x 6 in. and larger in multiples of 2 in.

Dressed sizes.

S1S, S1E, S2S or S4S.....  $\frac{1}{2}$  inch off

- A. **Manufacture.** All pieces shall be well manufactured. Miscut, tapered or wedge-shaped pieces will be rejected.
- B. **Rough Stock.** Rough material shall be sawn to the full nominal dimension except that occasional slight variation in sawing will be permissible. This variation in sawing will be interpreted as a deviation from the intended straight line of cut, which shall not exceed the following limits for the respective sizes:

Nominal Dimension	Allowable Variation in Sawing
2 inches.....	$\frac{1}{8}$ inch under or over
3 to 7 inches.....	$\frac{3}{16}$ inch under or over
8 inches and over.....	$\frac{1}{4}$ inch under or over

Not more than 20% of the pieces of any one size in any shipment shall be of the minimum dimensions. At least 80% of the pieces shall have the full nominal dimensions.

- C. **Surfaced Stock.** Surfaced material shall be furnished S1E, S2E, S1S1E, S1S2E or S4S, as specified in the contract. This material shall be surfaced to the size specified in the foregoing paragraph and shall be surfaced clean except that occasional slight skips where the planer did not surface smooth but not exceeding six inches in length, will be permitted. Floor plank furnished S1S or S1S1E shall be surfaced on the heart side.
- D. **Surfaced Hit or Miss Stock.** \*When so specified in the contract, material shall be furnished surfaced hit or miss S1S1E, S1S or S1E in accordance with the following:
- In the production of this material the planer shall be set to surface all pieces of width or thickness less than 8 inches, at  $\frac{1}{8}$  inch less than the full nominal dimension and all pieces of width or thickness 8 inches or more at  $\frac{3}{16}$  inch less than the full nominal dimension. All stock of greater thickness or width shall be dressed smooth. At least 80 per cent of the pieces of any one size in any shipment shall be surfaced as specified for the greater part of their length. That portion of each piece which



remains unsurfaced shall not be less than the foregoing dimensions by more than 1/16 inch in thickness or width. Note: \*Material covered by this specification is best adapted to use as floor plank when a perfectly smooth surface is not necessary but the maximum variation of "Rough" material is to be avoided.

E. **Seasoning.** When thoroughly air seasoned stock is furnished in "Rough" material, a tolerance of 2.0 per cent of the minimum specified dimension, but not exceeding  $\frac{1}{8}$  inch for sizes 7 inches and narrower, not more than  $\frac{1}{4}$  inch for sizes 8 inches and wider, will be accepted. No seasoning tolerance will be permitted in surfaced stock. The seasoning shall have been accomplished before the material is shipped or presented for inspection. In case of controversy regarding shrinkage of seasoned material and the resultant size of stock, the original green size of the material may be determined by soaking pieces in water.

**4138.04 SPECIES OF WOOD.** The species of wood specified below may be furnished under these specifications:

- A. **Class A.** Douglas fir or southern pine. For floor plank only, white oak, burr oak or post oak may be furnished when specified.
- B. **Class C.** Douglas fir, southern pine, west coast hemlock or ponderosa pine.
- C. **Class D.** Douglas fir or southern pine.

**4138.05 DEFINITION OF TERMS.** The terms used in these specifications shall be interpreted in accordance with the A. S. T. M. "Standard Definitions of Terms Relating to Timber", Designation D-9.

**4138.06 GRADING RULES.** The quality of all timbers and lumber furnished under these specifications shall conform to the following grading rules for the class specified:

- A. **Class A.** All untreated lumber in Class A shall conform to the requirements of the A. S. T. M. Specifications D-245 for the stress grades specified, as listed below:



## 1. Stress Grades.

Use	Nominal Size	Material	Stress Grade
Joist and Plank	3 and 4" thick 4" and wider	Close Grained Douglas Fir	1600 lb. f.
		Dense Southern Pine	1600 lb. f.
		Oak	1400 lb. f.
Beams and Stringers	5" and thicker 8" and wider	Close Grained Douglas Fir	1600 lb. f.
		Dense Southern Pine	1600 lb. f.
Posts and Timbers	6x6" and larger	Close Grained Douglas Fir	1200 lb. c.
		Dense Southern Pine	1200 lb. c.

2. Heartwood. Each piece shall show not less than 85% of heartwood measured on its girth.

3. Wane. No wane permitted. All edges must be square.

4. Heart Douglas Fir. Beams, stringers and caps of douglas fir shall be free of heart centers.

B. Class C. All material furnished under this class shall conform to the following standards according to the species of material:

Species	Grade Designation
Douglas Fir or west coast Hemlock	No. 1 Framing, Joists, Plank, and small timbers. No. 1 Boards and Sheathing
Southern Pine	No. 1 Shortleaf or Longleaf Dimension No. 1 Common Boards
Ponderosa Pine	No. 1 Common

The above lumber shall conform to the requirements of the grading rules adopted by regional associations of lumber manufacturers, which conform to the basic provisions of the "American Lumber Standards."

C. Class D. All material furnished in Class D shall conform to the requirements of the A. S. T. M. specifications D-245 for the stress grades specified, as listed below:

## 1. Stress Grades:

Use	Nominal Size	Material	Stress Grade
Joist and Plank	3 and 4" thick 4" and wider	Douglas Fir	1200 lb. f.
		Dense Shortleaf Pine	1200 lb. f.
		Oak	1100 lb. f.
Post and Timbers	6x6" and larger	Douglas Fir	1100 lb. c.
		Dense Shortleaf Pine	1100 lb. c.

2. Medium Grain. All materials shall show an average on one end or the other of not less than 4 annual rings per inch over a 3" line measured at right angles to the rings as specified for "Close Grain" or "Density" in Class A material.



**4138.07 CLASSIFICATION.** Bridge timbers and lumber which are not required to be treated will be classified as follows:

- A. **Class A.** All material for timber structures having a nominal thickness of 3" or over, except the items specified as Class C or D, shall be Class A.
- B. **Class C.** All lumber having nominal thickness less than 3 inches including bridging, laminated floors and baffle walls, shall be Class C.
- C. **Class D.** All lumber having nominal thickness 3 inches or over for maintenance or for construction items of backing plank, hand rails, rail posts, post blocks, curbs, hubguards, scupper blocks, diaphragms and baffle walls shall be Class D.

### Section 4139. Treated Timbers and Lumber

**4139.01 GENERAL REQUIREMENTS.** All rough and dressed treated timbers and lumber furnished under these specifications shall be new and unused material and shall conform to the following detailed requirements. The preservative treatment shall conform to the requirements of Section 4137 for "Pressure Treatment."

The Contractors attention is directed to provisions of Article 4101.05 for inspection requirements.

**4139.02 SPECIES OF WOOD.** Only Douglas Fir (Coast Region) and Southern Pine will be admitted under these specifications for treated timbers and lumber.

**4139.03 LENGTHS OF MATERIAL.** All lengths of materials furnished shall be in multiples of 3 feet unless otherwise specified in the contract documents.

**4139.04 MINIMUM ACCEPTABLE SIZES.** All material furnished shall comply with the requirements of Article 4138.03.

**4139.05 BORING, FRAMING and INCISING.** Unless specifically stated on the plans or proposals, whenever practicable, all framing, and boring shall be done before treatment. Douglas Fir lumber shall be incised before treatment. Incising shall be performed in accordance with requirements of Paragraph 4137.02 B.

On timber structures all holes required in stringers, rail posts, post blocks and scupper blocks shall be accurately bored before treatment. Holes for bolts shall be bored the same size as the bolt used.



**4139.06 CLASSIFICATION.** The grade of lumber furnished for preservative treatment shall be Class B, except when otherwise specified in the contract, and except for the following items of treated timber structures which shall be as follows:

Two inch material for laminated floors, cross bridging and handrails shall be Class C lumber, Section 4138.

Material three inches or more in thickness for Backing Plank, Rails, Rail Posts, Post Blocks, Curbs, Hubguards, Scupper Blocks and Diaphragms, shall be Class D lumber, Section 4138.

**4139.07 DEFINITION OF TERMS.** The terms used in these specifications shall be interpreted in accordance with the A. S. T. M. Standard "Definition of terms relating to timber" Designation, D-9.

**4139.08 GRADING REQUIREMENTS.** The requirements for Class C or D lumber to be treated will be found in Section 4138. The quality of Class B lumber to be treated shall conform to the requirements of the A. S. T. M. Specifications for Structural Timber D245 for the stress grades listed below:

**A. Stress Grades:**

Use	Nominal Size	Material	Stress Grade
Joist and Plank	3 and 4" thick 4" and wider	Close Grained Douglas Fir	1600 lb. f.
		Dense Southern Pine	1600 lb. f.
Beams and Stringers	5" and Thicker 8" and wider	Close Grained Douglas Fir	1600 lb. f.
		Dense Southern Pine	1600 lb. f.
Posts and Timbers	6x6" and larger	Close Grained Douglas Fir	1200 lb. c.
		Dense Southern Pine	1200 lb. c.

**B. Heartwood and Sapwood.** No limitation of heartwood or sapwood.

**C. Wane.** Wane will be permitted  $\frac{1}{8}$  the width of any face.

### Section 4140. Steel Piles

**4140.01 GENERAL.** Steel piles shall have the cross section specified in the contract documents and shall be rolled from steel conforming to the requirements of Article 4132.02.

### Section 4141. Concrete Piles

**4141.01 GENERAL.** Concrete piles shall be made of Class X concrete conforming to the requirements of Section 2403. They shall have the form, dimensions and reinforcement specified on the plans and shall be constructed and cured as provided in Articles 2501.03 and 2501.04.



## Section 4142. Timber Piles

**4142.01 DESCRIPTION.** Timber piles shall be round sections of the trunks of trees trimmed and peeled and with or without preservative treatment. They shall comply with the following requirements for the class of piles specified in the contract documents:

**4142.02 CLASSIFICATION.** Piles shall be classified as follows according to the use for which they are intended:

- A. **Untreated Timber Piles.** Untreated timber piles may be used for false work or temporary construction and for foundations below ground water level.
- B. **Treated Timber Foundation Piles.** Treated timber foundation piles will be used for foundations and for wood substructures above ground water level unless treated timber trestle piles are specified in the contract documents.
- C. **Treated Timber Trestle Piles.** Treated timber trestle piles shall be used for permanent wood trestles and may be specified for piers and abutments of substructures where the more restrictive straightness requirements of this class are desirable.

**4142.03 UNTREATED TIMBER PILES.** Timber piles to be used without preservative treatment may be White Oak, Burr Oak, Cypress, Tamarack, Douglas Fir, Southern Pine, or other wood which will satisfactorily withstand driving. They shall conform to the following provisions:

- A. **General Quality.** Piles shall be cut from sound solid trees. Piles shall be cut above ground swell. They shall be free from ring shakes, decayed wood, rot, soft "red heart", splits or other defects which would impair the strength of the pile. Piles shall be free from twist of grain exceeding  $\frac{1}{2}$  circumference in 20 feet of length and free from season checks more than  $\frac{1}{4}$ " wide. Holes shall not exceed  $1\frac{1}{2}$ " in diameter and shall not penetrate more than  $\frac{1}{5}$  the diameter of the pile at the point where they occur. Numerous holes or holes in groups will not be permitted. Cypress piles showing "peck" more than a single spot equal to 3% of the area of the end will not be accepted. Piles shall have a gradual taper from point of butt measurement to the tip.



**B. Knots.** Piles shall have no unsound knots. Sound knots will be permitted provided they are not in clusters and provided the width of the knot does not exceed  $\frac{1}{3}$  the diameter of the pile at the point where it occurs, with a maximum width of 4 inches. The sum of widths of all knots in any one foot length of pile shall not exceed two times the width of the maximum allowable knot. The width of knots shall be measured in a plane perpendicular to the axis of the pile.

**C. Grain.** When measured at the butt over the outer 3 inches of a radial line from the pith, piles shall show not less than the number of annual rings and percentage of summer wood specified below for the respective species:

Species	Rings Per Inch	Summer Wood Minimum Percentage
Douglas Fir Douglas Fir	More than 5 4 to 5	33 $\frac{1}{3}$ %
Southern Pine Southern Pine	More than 5 3 to 5	33 $\frac{1}{3}$ %
Other Species	5	-----

When the number of annual rings varies along different radii the average of two or more measurements along representative radii shall be used.

**D. Length.** Piles shall be furnished in the length specified on the plans or as ordered in writing by the Engineer. These lengths will be specified in even multiples of 2 feet for lengths 30 feet or less and in multiples of 5 feet for lengths greater than 30 feet. A variation of 6 inches in length will be permitted but the average length for piles of any one lot shall be at least equal to the specified length.

**E. Straightness.** Piles shall be free from short crooks or bends which deviate from straightness more than 4 per cent of the length of any section 5 feet or less in length. Piles shall be free from bends in more than one plane. The center of the pile shall not deviate from a straight line connecting the center of the butt with the center of the tip by more than 1% of the length of the pile or 4 inches whichever is the greater limit. Piles with reverse bends in the same plane may be accepted provided the reversal is within the middle half of the length and provided the deviation of the center of the pile from a straight line connecting the center of the butt with the



center of the tip does not exceed  $\frac{1}{2}$  of the foregoing limits.

- F. **Dimensions.** At least 95% of the pieces of one length in any shipment shall conform to the following dimensions for the species of wood specified. The remaining 5.0% of the pieces may be deficient in diameter at tip or 3 feet from butt by not more than  $\frac{1}{2}$  inch.

	Minimum Diameter 3 feet from Butt		Minimum Tip Diameter
	Fir and Pine	Other Species	
20' and shorter	Natural Taper	11 Inches	8 $\frac{1}{2}$
22' to 30'	11 Inches	12 Inches	8
35'	12 Inches	13 Inches	8
40'	12 Inches	13 Inches	7
45' to 60'	13 Inches	14 Inches	7
60+	13 Inches	14 Inches	6

The diameter of no pile, at the butt, shall exceed 20 inches. Diameters of piles shall be measured after removal of the bark.

- G. **Workmanship and Finish.** All knots and limbs shall be trimmed or smoothly cut flush with the surface of the pile. Butt and tip shall be cut square with the axis of the pile. On all species all the outer bark shall be removed. All piles shall be plainly marked on the butt with the length in feet.

- H. **Inspection.** The contractor's attention is directed to provisions of Article 4101.05 for requirements for preparation of material for inspection. The inspector will make a thorough examination of each pile. Each pile will be judged without regard to decisions on others of the same lot. Piles too muddied for ready examination will be rejected. At the expense of the producer piles will be turned over as inspected.

The diameter of tip and butt will be determined by measuring the circumference and dividing by 3.14. In case the piles have been cut so long that there is possibility of deterioration, the inspector may require that each pile be recut on both butt and tip, not less than two inches from the original end, to provide a freshly cut section for examination. The appearance of any incipient decay on a fresh section shall be sufficient cause for rejection of the stick.

4142.04 **TREATED TIMBER FOUNDATION PILES.** Piles for treated wood foundations shall conform to the requirements



for untreated wood foundation piles, Article 4142.03 and with the following additional requirements:

- A. Species. The pile shall be either Southern Pine or Douglas Fir.
- B. Peeling. All piles shall be peeled by removing all of the rough bark and at least 80 per cent of the inner bark. No strip of inner bark remaining on the pile shall be over  $\frac{3}{4}$  inch wide or over 8 inches long, and there shall be at least one inch clean wood surface between and 2 such strips. Not less than 80 per cent of the surface of any circumference shall be clean wood.
- C. Preservative Treatment. The piles shall be given pressure preservative treatment in accordance with the requirements of Section 4137. The preservative used shall be creosote oil conforming to the requirements of paragraph 4136.01. Ring shakes, checks, "water bursts", or similar defects which develop during the treating process will be considered cause for rejection.

**4142.05 TREATED TIMBER TRESTLE PILES.** Piles to be used in construction of permanent wood trestles and when specified for piers or abutments with wood backing plank, shall conform to requirements of Article 4142.04 "Treated Timber Foundation Piles", except that the straightness of pieces shall meet the following requirements:

- A. Straightness. Piles shall be free from reversed bends. Piles shall be free from short bends which deviate from straightness more than 4% of the length of any section 5 feet or less in length. The center of the pile shall not deviate from a straight line connecting the center of the tip with the center of the butt by more than 1% of the length of the pile or 3 inches, whichever is the lesser limit.

### Section 4143. Wood Posts

**4143.01 GENERAL REQUIREMENTS.** All posts furnished shall conform to the detailed requirements hereinafter stated for one of the classes listed below as specified in the contract documents.

Round Wood Posts

Sawed Wood Posts

The contractor's attention is directed to provisions of Article 4101.05 for inspection requirements.



**4143.02 ROUND WOOD POSTS.** All round wood posts shall be cut from sound and solid trees. They shall contain no unsound knots. Sound knots will be permitted provided the width of the knot does not exceed  $\frac{1}{3}$  the diameter of the piece at the point where it occurs or a maximum of  $2\frac{1}{2}$  inches. Posts shall be free from decayed wood, rot, "red heart", ring shake, season checks more than  $\frac{1}{4}$  inch wide and from splits in the end. When measured over the outer 2 inches of a radial line from the pith. Douglas fir posts shall show not less than 5 annual rings per inch and pine posts shall show not less than 3 annual rings per inch and not less than 30 per cent of summer wood. Posts shall not show spiral grain exceeding  $\frac{1}{4}$  turn in 10 feet. Groups of knots or any combination of defects which impairs the strength more than the maximum size knot will not be permitted.

**A. Species.** The species of wood of posts furnished under these specifications shall be that called for on the plans or proposals with the following limitations:

1. Posts which are to be given pressure preservative treatment shall be Southern Pine or Douglas Fir.
2. Posts which are to be given preservative treatment on butts only shall be Cypress or White Cedar.
3. Untreated posts shall be White or Burr Oak, Black Locust, Osage Orange or Red Cedar.

**B. Size.** The size of posts will be specified by even inches of the diameter of the top. Posts will be accepted only when the top diameter equals the specified dimensions or exceeds it by not more than  $\frac{3}{4}$  inch and provided the range in top diameter from largest to smallest in any lot of 1 carload or less shall not exceed  $\frac{1}{2}$  inch. This diameter shall be determined from the circumference, after peeling, divided by 3.14.

**C. Length.** Round wood posts will be furnished in the length specified plus or minus 2.0%.

**D. Straightness.** Posts shall be free from bends in more than one plane and free from short or reverse bends. A straight line from center of tip to center of butt shall not deviate from the center of the post by more than 2% of the length of the post.

**E. Workmanship.** All posts shall be peeled for their full length and all bark and inner skin removed. The part of the post which will remain out of the ground shall



be shaved clean and free from glazed surface left by dried sap. All knots or projections shall be shaved smooth and flush with the surface of the surrounding wood.

When so specified in the contract the tops of posts shall be shaped to a true hemispherical surface which shall have the same diameter specified for the posts and shall have its axis coincident with the axis of the post.

F. **Preservative Treatment.** When so stipulated in the contract documents, posts shall be given preservative treatment in accordance with provisions of Section 4137 for the species of post specified.

G. **Inspection.** The posts shall be inspected before being treated. The Contractor shall notify the State Highway Commission at Ames, Iowa, of the name and location of the company furnishing the posts. If the posts are to be treated at the source of supply such notice shall be given sufficiently in advance of the date of treatment to allow for the selection and testing of samples of the preservative which is to be used. The inspector shall have free access to all parts of the treating plant and the plant shall be equipped with instruments for accurate measurement of the treating process.

Posts which are to receive nonpressure treatment only may be treated after delivery at the site of the work.

**4143.03 SAWED WOOD POSTS.** Sawed wood posts shall conform to the requirements of Section 4138 "Untreated Timber and Lumber".

A. **Size.** Posts shall conform to the shape and nominal dimensions specified in the contract documents.

B. **Preservative Treatment.** All posts when so stipulated on plans or proposals, shall be given preservative treatment in accordance with the methods specified in Section 4137, and with creosote oil specified in Article 4136.01.

### Section 4144. Subgrade Paper

**4144.01 SUBGRADE PAPER.** Paper to be used for insulating the subgrade of concrete pavement shall comply with the requirements of A.A.S.H.O. M-74.



## Section 4145. Curing Paper

**4145.01 CURING PAPER.** Paper to be used for curing of concrete shall comply with the requirements of A.S.T.M. C-171, except that in lieu of the moisture loss requirement prescribed the following shall apply. The moisture loss shall not be greater than 5.0 per cent of the original mixing water used when the paper is tested in the manner prescribed, except that the paper shall remain in place for 24 hours.

The paper shall comply with the following additional requirements:

The paper shall be prepared in sheets of sufficient width to cover the full width of concrete surface being placed with normal allowance for shrinkage. When forms are removed during the curing period the full height of the pavement edge, including curb, shall be covered by a supplemental or stringer strip which shall be wide enough to cover the pavement edge and extend over the surface of the slab to lap the main sheet not less than 12 inches.

## Section 4146. Burlap for Curing Concrete

**4146.01 BURLAP.** The burlap used for curing concrete shall comply with the following requirements. The average dry weight per square yard of fabric shall be not less than 9.0 ounces. The ash based on the dry weight of the burlap shall be not more than 3.0%.

The burlap shall be composed of not less than 95% jute and manila fibers.

The burlap shall have had no contact with lanolin, wool, sugar, molasses, or other substance that might have a deleterious affect upon fresh concrete. The burlap used for curing concrete pavement shall be sewn into covers of width sufficient to cover the full width of concrete surface to be covered, plus 1 foot.

When forms are removed during the specified period of curing with burlap the covers shall extend to the full thickness of the pavement at the edge including curb. If this extension is with a supplemental sheet the supplemental strips shall extend on the slab surface to lap the main sheet not less than 12 inches.



## Section 4147. Liquid Curing Compounds

**4147.01 DESCRIPTION.** Liquid compounds for curing concrete may be either dark colored compounds of asphalt emulsified or cut back with volatile solvent, or light colored compounds consisting of a non-volatile base of waxes, resins or gums with a volatile solvent. The compounds shall comply with the following additional requirements for respective types:

**4147.02 MOISTURE RETENTION.** When tested in accordance with the method prescribed in article 4147.06 the efficiency index of the material shall not be less than 95.0, except that material showing a moisture loss less than 1.0 per cent of the quantity of water remaining in the test specimen at the time the curing material is applied will be acceptable.

**4147.03 SETTING.** Liquid curing compounds shall set within 2 hours after application to form a firm, water impermeable film adhering strongly to the concrete.

**4147.04 LIGHT COLORED COMPOUNDS.** Light colored curing compounds shall contain a fugitive dye to assist in securing uniform coverage. The color of the compound applied to the moisture retention test specimen shall, after the completion of the moisture retention test, not be so dark as to cause a temperature rise of more than 5°F. above that of a blank specimen under similar exposure to infra red light. The rate of application to be used shall be determined from the results of the moisture retention test except that in no case shall the rate of application be less than 0.067 gallons per square yard. (Coverage 15 square yards per gallon.)

**4147.05 DARK COLORED COMPOUNDS.** Dark colored curing compounds shall set sufficiently in 2 hours after application that the white-wash coating specified in Paragraph 2301.24C will not be discolored.

The rate of application to be used will be determined from the results of the moisture retention test except that in no case shall the rate of application be less than 0.08 gallons per square yard. (Coverage 12.5 square yards per gallon).

**4147.06 METHOD OF TEST.** The efficiency of liquid curing compounds in preventing the escape of moisture from concrete shall be determined in accordance with A.S.T.M. C-156, with the following modifications:



- A. **Fine Aggregate.** The fine aggregate used in the mortar for test specimens shall be sand complying with the requirements of Section 4104.
- B. **Preliminary Storage of Mortar Specimens.** The mortar test specimens shall be cast in advance and be stored for 16 to 20 hours under individual impervious covers, in the moist storage room before the liquid curing compound is applied.
- C. **Length of Curing Period.** The length of the curing period measured from the time the curing compound is applied to the specimens shall be 24 hours.
- D. **Calculation of Loss in Weight.** The loss in weight of all specimens shall be calculated from the weight determined at the time the curing compound is applied to the test specimens. Any loss in weight of the specimens between the time they are molded and the time the curing compound is applied shall be assumed to be a loss of the original mixing water.

### Section 4148. Plant Material

**4148.01 DESCRIPTION.** Plant material shall include all trees and shrubs used in roadside improvement. All plant material shall conform in size and grade to Horticultural Standards of the American Association of Nurserymen for the sizes set forth in the contract documents and shall comply with the following requirements.

**4148.02 TAGGING OF MATERIALS.** All stock furnished must be true to name and legibly tagged with the name and size of the material according to the general nursery standards of practice as recommended by the American Association of Nurserymen.

**4148.03 SAMPLES.** The Engineer may require samples to be submitted before stock is shipped from the nursery to the planting site. The material delivered shall conform to the samples submitted.

**4148.04 INSPECTION OF PLANT MATERIAL.** Inspection of plant material will be made at the nursery or collecting field by an authorized representative of the County whenever such examination is deemed desirable. Approval of material on such examination shall not be construed as an acceptance of it. Final acceptance will not be made until the material has



been delivered and installed. No plants shall measure less than the minimum specified and all plant material shall average the mean of the sizes specified. The material shall meet the following standards:

- A. **Deciduous Trees.** Deciduous trees shall meet the following standard heights for the corresponding caliper, measurement taken 6 inches above the collar:

Sizes of Ornamental Deciduous Trees

Caliper	Minimum Heights	Caliper	Minimum Heights
1 to 1 $\frac{1}{4}$ "	8 to 10 ft.	2 $\frac{1}{2}$ to 3"	12 to 14 ft.
1 $\frac{1}{4}$ to 1 $\frac{1}{2}$ "	8 to 10 ft.	3 to 3 $\frac{1}{2}$ "	14 to 16 ft.
1 $\frac{1}{2}$ to 1 $\frac{3}{4}$ "	10 to 12 ft.	3 $\frac{1}{2}$ to 4"	14 to 16 ft.
1 $\frac{3}{4}$ to 2"	10 to 12 ft.	4 to 5"	16 ft. and up
2 to 2 $\frac{1}{2}$ "	12 to 14 ft.	5 to 6"	16 ft. and up

- B. **Balled and Burlapped Trees.** Balled and burlapped trees shall meet the following requirements for number of transplantings and sizes of balls.

1. **Prostrate and Spreading types (Pfitzer, Sairus, etc.)**

18-24" size 2 transplantings 12" diameter ball

2-3' size 3 transplantings 16" diameter ball

3-4' size 4 transplantings 18" diameter ball

2. **Upright Medium Height Types (Chiu, Column, Com-mart, etc.)**

1 $\frac{1}{2}$  to 2' size-2 transplantings—12" diameter ball

2 $\frac{1}{2}$  to 3' size-3 transplantings—13" diameter ball

3 $\frac{1}{2}$  to 4' size-3 transplantings—14" diameter ball

4 $\frac{1}{2}$  to 5' size-4 transplantings—16" diameter ball

5 $\frac{1}{2}$  to 6' size-4 transplantings—18" diameter ball

3. **Large Tree Types (Pine, Spruce, etc.)**

3 to 4' size-3 transplantings—16" diameter ball

4 to 5' size-4 transplantings—18" diameter ball

5 to 6' size-4 transplantings—20" diameter ball

4. **Thorn.**

2 to 3' size-3 transplantings—14" diameter ball

3 to 4' size-3 transplantings—15" diameter ball

4 to 5' size-3 transplantings—16" diameter ball

5 to 6' size-4 transplantings—18" diameter ball

4148.05 **GOVERNMENT INSPECTION.** All plant material shall comply with State and Federal laws with respect to inspection for plant disease and infestation. Any inspection certificates required by law to this effect shall accompany each



shipment, invoice or order of stock; and on arrival the certificate shall be filed with the Engineer in charge.

**4148.06—PREPARATION FOR SHIPMENT.** All trees shall come directly from the nursery row and shall be dug with reasonable care and skill immediately previous to shipment. On projects planted in the spring the only plant material that will be accepted from cold storage will be shrub and ground cover types. Precautions shall be taken to avoid any unnecessary injury or removal of fibrous roots. Each species or variety shall be handled and packed in the approved manner for the plant, having regard for the soil and climatic condition at the time of digging, the conditions of transit, and the time that will be consumed in transit or delivery. All precautions that are customary in good trade practice shall be taken to insure the arrival of the plants at destination in good condition for successful growth. All plants which are to be balled and burlapped previous to the shipment, are designated (B & B) in the itemized list of plant materials. Balled and burlapped plants shall be lifted so as to retain as many fibrous roots as possible. The burlap shall be firmly held in place by a wrapping of stout cord or wire. All balled and burlapped material must come from soil which will hold a firm ball and arrive in good condition. The balls shall be firm and sound. No broken or loose balls will be accepted.

**4148.07 TRUCK SHIPMENT.** Where shipment is made by truck, all material shall be packed in such a manner as to insure adequate protection against climatic, seasonal, or other injuries during transit. Deciduous trees and shrubs shall be placed in bundles and the roots shall be carefully protected with wet straw, moss or other suitable material which will insure the arrival of plants at destination with the roots in a moist, healthy condition. Material transported in open-body trucks must be protected with tarpaulin coverings.

**4148.08 RAIL SHIPMENT.** Where shipment is made by rail box cars shall be adequately ventilated in accordance with the plant requirements to prevent any "sweating" during transit. Special attention shall be given to prompt delivery and careful handling from the freight yard to the point of delivery.

**4148.09 QUALITY OF PLANT MATERIAL.** All of the plants shall be first-class representatives of their normal species or variety. Plants shall have average or normal well-developed



branch systems, together with vigorous root systems. Plants shall be free from disfiguring knots and sun scald injuries, abrasions of the bark, or other objectionable disfigurements. Plants must show appearance of normal health and vigor in strict accordance with these specifications. All stock shall be nursery grown.

Any plant material with broken, short or shriveled roots, broken branches or cut back leaders, or which otherwise fails to comply with these specifications in any way, will be rejected and shall be immediately removed by the contractor.

### Section 4149. Miscellaneous Materials

**4149.01 PARTING STRIPS.** Parting strips for concrete pavements shall be one of the three following types:

- A. Metal parting strip shall be coated or uncoated sheet metal not lighter than 18 guage, formed and punched to receive channel shaped pins to be driven into the subgrade at not more than 2 foot intervals and to receive the number and size of transverse reinforcement bars shown on the plans. Its width shall be  $\frac{1}{2}$  inch less than the thickness of the pavement, and shall not vary more than  $\frac{1}{8}$  inch from this dimension.
- B. Pre-moulded bituminous parting strip shall be saturated and coated felt having the dimensions shown on the plans.

**4149.02 METAL EXPANSION TUBES.** Expansion tubes to be used on dowel bars through expansion joints shall be non-collapsible tubes with one end closed. They shall be formed with a positive bar stop capable of withstanding a push of more than 20 pounds. The stop shall be located 3 inches from the open end of the tube. Each tube shall have an internal diameter of  $\frac{1}{16}$ " larger than the nominal diameter of the bar. The length of that part of the tube having this diameter shall not be less than 3", plus the thickness of the expansion joint.

**4149.03 BRONZE METAL.** Bronze shall conform to the requirements of the A.S.T.M. Designation B22. "Class A or B" metal will be admitted unless otherwise shown on the plans.

**4149.04 HYDRATED LIME.** Hydrated lime shall comply with the requirements of the A.S.T.M. Designation C6.

**4149.05 CALCIUM CHLORIDE.** Calcium chloride used for dust prevention or for an admixture in concrete shall comply with the requirements of the A.S.T.M. Designation D98.



## DIVISION 42. MAINTENANCE MATERIALS

This part consists of requirements for materials used in maintenance as set forth in the following sections.

Section 4201. Solid Bitumens for Pavement Maintenance.

Section 4202. Bituminous Premix.

Section 4203. Black Centerline Marking Paint.

Section 4204. Rock Asphalt.

Section 4210. Antifreeze.

Section 4211. Automotive Storage Batteries.

Section 4220. Hardware.

Section 4221. Cutting Edges.

Section 4222. Tie and Brace Wires.

Section 4223. Mower Parts.

Section 4224. Steel Sign Posts.

Section 4225. Steel Snow Fence Posts.

Section 4230. Snow Fence.

Section 4231. Wood Sign Posts.

Section 4240. Concrete for Pavement Repair.

Section 4250. Diesel Fuel.

Section 4251. Gasoline.

Section 4252. Greases.

Section 4253. Hydraulic Hoist Oil.

Section 4254. Lubricating Oil.

Section 4255. Regular Transmission Oil.

Section 4256. Extreme Pressure Transmission Oil.

Section 4260. Grass and Legume Seed.

Section 4272. Railroad Crossing Signs and Posts.

Section 4273. Wood sign Boards.

Section 4280. Enamel for Equipment and Metal Signs.

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### Section 4201. Solid Bitumens for Pavement Maintenance

**4201.01 GENERAL.** Solid bituminous material for use in filling cracks in rigid pavement shall be one of the following types as specified in the contract.

- A. Native asphalt meeting requirements of A.A.S.H.O. Specification M-22 for penetration grade 85 to 100.
- B. Petroleum asphalt meeting requirements of A.A.S.H.O. Specification M-20 for penetration grade 100 to 120.



C. Mixed asphalt and mineral filler meeting requirements of A.A.S.H.O. Specification M-89 Penetration Grade 60-70.

D. Tar meeting requirements of A.A.S.H.O. Specifications M-52 for grades RT-10 or RT-11.

**4201.02—CONTAINER.** Solid bituminous material for maintenance of pavement will be shipped in tight double end metal containers known as one time shipping containers. They shall be made with double lock seams which will not leak in handling or storage and with a single filling opening approximately 6 inches in diameter, in the head, closed with a tight friction lid.

**4201.03 INSPECTION.** Solid bituminous material for maintenance of pavement will be inspected at the producing plant unless otherwise specified.

**4201.04—METHOD OF MEASUREMENT.** Solid bitumens for maintenance of concrete pavement will be measured in tons of 2000 pounds avoirdupois net weight. In computing the net weight of the bituminous material an average tare weight may be determined from the weight before filling of not less than 10% of the number of containers in the shipment.

**4201.05 BASIS OF PAYMENT.** For the number of net tons of solid bituminous material furnished and accepted, as provided above, the Contractor will be paid the contract price therefor. This price shall be full compensation for furnishing all materials including the containers and for preparing and shipping the material with freight prepaid to the specified destinations.

## Section 4202. Bituminous Premix

**4202.01 GENERAL.** Bituminous premix shall consist of aggregate of the size specified, thoroughly mixed with bitumen and conforming with the following requirements. Unless otherwise specified the bitumen shall be MC-4. The final mixture shall have all particles well coated with bitumen and shall be free from dirt or other foreign material and free from hard lumps of partially cemented materials.

A. **Aggregate.** The aggregate for bituminous premix shall conform to the requirements of Section 4112. Unless otherwise specified, the  $\frac{3}{4}$  inch size shall be furnished.

B. **Bitumen Content.** When a representative sample of the mixture is extracted with hot carbon tetrachloride



( $\text{CCl}_4$ ) the bitumen content shall be between 0.90 and 1.10 of the ratio required by the following formula:

$$R=0.04A+0.15C+2.10$$

$$G = \frac{6.49 R \times \text{Sp. Gr. (b)}}{\text{Sp. Gr. (a)}}$$

In which R=Bitumen aggregate ratio in pounds per pound.

G=Bitumen in gallons per ton of aggregate.

Sp. Gr. (a)=Specific gravity of aggregate at 77°F.

Sp. Gr. (b)=Specific gravity of bitumen at 77°F.

A=Surface area of aggregate in square feet per pound.

C=Surface coefficient of aggregate.

Factors for surface coefficient and for computing surface area will be furnished by the Laboratory after analysis of samples of aggregate.

C. **Hveem Stability.** A briquette of the final mixture 4 inches in diameter by 2 to 2½ inches in height compacted at 140°F. by tamping and by pressure of 3000 lb. per square inch, when cooled to room temperature and tested in the Hveem stabilometer under a pressure of 400 lb. per square inch shall show an increase in lateral pressure from 5 lb. per square inch, initial pressure, to not more than 60 pounds per square inch.

D. **Modified Hubbard Field Stability.** When that portion of the mixture passing the #8 sieve is tested in accordance with modified Hubbard field method as specified in Paragraph 4101.02H, it shall show the following stabilities:

1. Compacted at 140°F. and tested at 120°F., stability not less than 1200 lb.
2. Compacted at room temperature 70 to 80°F. and tested at 120°F., stability not less than 50% of that developed when compacted at 140°F.

E. **Analysis.** Samples for analysis and stability tests shall be heated for 20-21 hours in an oven at 210-225°F. to remove moisture and volatile portions of the bitumen. Analysis of samples shall be in accordance with A.A.S. H.O. Standard Method T-58 except that the solvent shall be  $\text{CCl}_4$  and after extraction the sample shall be dried



at 225-230°F. to remove traces of solvent and moisture. All friable lumps shall be broken up by rubbing with a rubber pestle and the material shall be moistened with 50cc of methyl alcohol and washed over the #200 sieve.

**4202.02 METHOD OF MEASUREMENT.** The quantity of bituminous premix delivered will be determined in tons of 2000 lb. net weight avoirdupois. This net weight will be obtained from railroad weights of full car load shipments or scale weights of individual truck shipments.

**4202.03 BASIS OF PAYMENT.** For the number of tons of bituminous premix of acceptable quality measured, as prescribed above, the Contractor will be paid the contract price therefor.

### Section 4203. Black Centerline Paint

**4203.01 GENERAL.** Black paint for marking centerlines of pavements shall be mixture of tar pitch and oils which are closely fractionated tar distillates. The character of the pitch shall be such that the finished paint will remain homogeneous and free from settlement of coke like material. It shall conform to the following requirements:

- A. When tested with Saybolt-Furol Viscosimeter the paint shall show viscosity of 45-60 seconds at 77°F.
- B. When distilled in accordance with A.S.T.M. Standard Method D-20 the paint shall show a total distillate to 300°C of 25 to 50 percent.
- C. The amount of water in the paint shall not exceed 1.0%.
- D. When brushed on a glass plate at a rate of 300 to 400 square feet per gallon the paint film shall be set to touch within 30 minutes.
- E. The color of the paint shall be a dense lustrous black.
- F. The softening point of the tar pitch used in the manufacture of the paint shall not exceed 160°F. when tested by the cube-in-water method, A.S.T.M. Standard D-61.

**4203.02 CONTAINERS.** Black centerline marking paint will be shipped in metal drums containing approximately 53 gallons each. Drums shall be tight metal containers either new or used. They shall be clean before filling and any questionable drum shall be pressure tested for leaks. Drums shall have 2 rolling hoops, one filling bung not smaller than 2 inches and one vent bung in the head not smaller than ¾". Bungs shall



be fitted with cast iron plugs with standard pipe threads and fiber gaskets.

**4203.03 INSPECTION.** The Contractor shall submit samples of the material he proposes to furnish in advance of manufacture. The preparation of black centerline paint will be inspected at the producing plant unless otherwise specified.

**4203.04 METHOD OF MEASUREMENT.** Black centerline marking paint will be measured in U. S. Standard Gallons at 60°F. The net quantity of material will be determined by weight. In computing the net weight an average tare weight of the containers may be determined from the weight before filling of not less than 10% of the number of containers in the shipment.

**4203.05 BASIS OF PAYMENT.** For the number of gallons of black centerline marking paint conforming with these specifications, measured as provided above, delivered to the points specified, the Contractor will be paid the contract price therefor. This price shall be full compensation for furnishing all materials including containers, and for preparation and shipment, with freight prepaid to the specified destinations.

## Section 4204. Rock Asphalt

**4204.01 GENERAL.** Rock asphalt shall consist of sandstone naturally impregnated with bitumen to which additional bitumen may be added after the material has been crushed and pulverized. For the purpose of this specification, rock asphalt to which bitumen has been added after it has been mined will be referred to as Fluxed Rock Asphalt, and rock asphalt containing no bitumen other than that occurring naturally in the material will be referred to as Natural Rock Asphalt. The bidder shall state on his proposal which of these two products he proposes to furnish.

The rock asphalt shall be uniform in composition and shall not contain more than 3 per cent of particles not completely coated with bitumen. It shall comply with the following additional requirements:

**A. Deleterious Materials.** The rock asphalt shall not contain more than 3 per cent of sulphate, iron pyrites and aluminate. It shall be free from dirt, coal and other foreign material.



**B. Size of Particles.** When tested by means of laboratory sieves at a temperature between 80 and 100 F. the percentage passing the  $\frac{3}{4}$  inch sieve shall not be less than 95 and the percentage passing the  $\frac{3}{8}$  inch sieve shall not be less than 75.

**E. Rock Asphalt to be Fluxed.** Rock asphalt to which bitumen is to be added shall contain not less than 4 per cent of bitumen and not more than 0.3 per cent of moisture at the time it is fluxed. The asphalt used for fluxing shall be of the type and grade approved by the Engineer and shall comply with the requirements herein specified for that type and grade.

**D. Percentage Soluble in Carbon Tetrachloride.** The percentage soluble in carbon tetrachloride as determined on a dehydrated sample of the rock asphalt in a manner similar to that prescribed in A. S. T. M. Designation D147 shall comply with the following requirements:

1. Natural Rock Asphalt, not less than 6 nor greater than 9.
2. Fluxed Rock Asphalt, not less than 8 nor greater than 11.

**E. Particle Size of Extracted Aggregate.** When the aggregate from which the bitumen has been extracted as described above has been dried at a temperature between 225 and 235 F. and tested by means of laboratory sieves the material shall comply with the following requirements:

Sieve Size	Percentage Passing			
	Natural Rock Asphalt		Fluxed Rock Asphalt	
	Min.	Max.	Min.	Max.
No. 10	90	100	90	100
No. 200	5	12	10	25

In performing this test all friable lumps shall be broken by gentle rubbing with a rubber pestle and the sample shall be moistened with methyl alcohol and washed through the No. 200 sieve with water.

**F. Stability.** When tested in accordance with the method specified in Paragraph 4101.02 H the stability of the rock asphalt shall comply with the following requirements:



Molding Temperature	Stability	
	Natural Rock Asphalt	Fluxed Rock Asphalt
140 F 70 to 80 F.	750 pounds Not less than 50 per cent of stability when molded at 140° F.	1200 pounds

**4204.02 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.** Rock asphalt shall be measured and paid for as provided for Bituminous Premix, Section 4202.

### Section 4210. Antifreeze

**4210.01—GENERAL.** The anti-freeze shall be of permanent nature with boiling point higher than water. It shall be suitable for use with water as the cooling medium in the radiator systems of internal combustion engines used in Highway work. The anti-freeze shall comply with the following requirements:

- A. It shall be miscible with water to not less than 97%.
- B. The specific gravity at 60°F. shall be from 1.110 to 1.125.
- C. The residue from ignition shall not exceed 0.5%.
- D. When 100 ml. of the anti-freeze is distilled from a 250 ml. MCA Flask using an air cooled condenser 430 to 470 mm. in length the following conditions shall be obtained:
  1. When 5% of the sample has been recovered in the receiver the thermometer shall read not less than 275°F.
  2. When 95% of the samples has been recovered in the receiver the thermometer shall read not more than 430°F.
- E. A 50-50 mixture by volume of the anti-freeze and water shall show no tendency to foam when heated to 180°F. and agitated vigorously in such a manner to cause air to be beaten into the solution.
- F. The freezing point of a 50-50 mixture by volume of anti-freeze and water shall not be higher than 25° below zero F.
- G. The anti-freeze shall contain proper inhibiting agents capable of preventing the formation of rust in the cooling pipe lines of internal combustion engines.
- H. The anti-freeze shall be of such nature that it will not attack copper, bronze, brass, aluminum, iron or any other



metal used in construction of the cooling systems. It shall not attack radiator hose or be injurious to automotive paint finishes.

**4210.02 CONTAINERS.** The anti-freeze shall be packed in sealed cans, each containing 1 U. S. Standard gallon at 60°F. with 6 cans packed in case or carton.

**4210.03 MEASUREMENT AND PAYMENT.** For the number of gallons of acceptable anti-freeze delivered to the points specified the Contractor will be paid the contract price per gallon.

### Section 4211. Automotive Storage Batteries

**4211.01 GENERAL.** These specifications are intended to apply only to lead acid storage batteries for automotive purposes. All batteries shall be of 3 cell type.

**4211.02 BATTERY SIZES AND CAPACITIES.** The sizes and capacities of the batteries furnished shall be as follows:

Item No.	Corresponding S.A.E. Case Size	Overall Dimensions Inches Maximum			Min. Cap. at 20 Hr. Rate Amp. Hrs	Min. Time at 30 Amps O Deg. F. Minutes	Min. 5-Sec. Volts at 300 Amps O Deg. F.	Type of Service Intended
		Length	Width	Height				
1	2 L	10 $\frac{3}{8}$	7 $\frac{1}{4}$	8	100	3.20	4.20	Auto
2	1 M	9 $\frac{3}{8}$	7 $\frac{1}{8}$	9 $\frac{1}{8}$	90	3.00	4.10	Auto
3	1 ME	19 $\frac{3}{8}$	4 $\frac{1}{8}$	9 $\frac{1}{8}$	96	3.10	4.15	Auto
4	2 M	10 $\frac{3}{8}$	7 $\frac{1}{8}$	9 $\frac{1}{8}$	105	3.70	4.20	Auto or truck
5	2 ME	19 $\frac{3}{8}$	4 $\frac{1}{8}$	9 $\frac{1}{8}$	110	4.00	4.25	Auto or truck
6	3 H	11 $\frac{3}{4}$	7 $\frac{1}{8}$	9 $\frac{3}{8}$	133	5.30	4.40	Truck
7	2 T	15 $\frac{1}{8}$	7 $\frac{3}{8}$	10 $\frac{1}{2}$	137	2.75	3.65	Truck

A. The dimensions of the batteries shall be determined and the cell assembly shall be in accordance with the 1946 S.A.E. Standards.

B. Tests to determine the capacities of the batteries shall be in accordance with methods outlined in Notes for Storage Batteries, 1946 S.A.E. Standards.

C. Any batteries purchased other than those listed above shall conform to the ratings and dimensions set forth in the manufacturer's schedule submitted with the bid.

**4211.03 CASES.** All batteries shall be furnished in rubber cases.

**4211.04 INSULATION.** All truck batteries shall have double insulation.



**4211.05 SAMPLING AND TESTING.** Upon the award of contract, batteries of the various sizes will be ordered as needed. Upon receipt of each shipment, a representative sample will be tested.

Additional tests will be made upon batteries delivered throughout the contract period as the Engineer may direct.

**4211.06 GUARANTEE AND ADJUSTMENT.** The National Battery Manufacturers' Association guarantee and adjustment policy shall apply to all batteries delivered under the contract.

**4211.07 BASIS OF PAYMENT.** For batteries which conform to the requirements of the specification the contractor will be paid the contract price each. Should the first shipment of batteries after award of contract fail to comply with the specifications, the producer will be notified by telegraph and will be given 5 days in which to supply batteries which comply with the specifications. After this five day period and on succeeding shipments which fail to comply with specification requirements, the County reserves the right to use such batteries as are needed and pay for them at a reduced rate as outlined below.

When 10 percent of the batteries in any lot are tested and results averaged, a deduction of 5.0% of the contract price will be made for each 1.0% that this average test result fails to comply with the specification requirements, based on that test by which the batteries fail by the greatest margin.

The producer may at any time replace any unused batteries purchased at the reduced price, with batteries which comply with the specification requirements.

## Section 4220. Hardware

**4220.01 GENERAL.** Under the general designation of Hardware the following categories of articles shall be furnished:

- A. Machine bolts, nuts, studs, and tap rivets
- B. Machine screws
- C. Stove bolts
- D. Round unslotted head bolts
- E. Cap Screws
- F. Plow Bolts
- G. Zinc coated sign bolts
- H. Washers
- I. Cotter pins



J. Nails, Spikes, Staples and Tacks

K. Wood Screws

Workmanship for each category shall be compatible with the standard type of product, class of fit and finish specified, and shall compare well with the product as produced in standard manufacturing processes of the article specified.

The form and fit of all screw threads, both external and internal, shall be in accordance with the American National Standard Screw Threads for bolts, Nuts, Machine Screws and Threaded Parts, ASA-B1.1-1935.

**4220.02 MACHINE BOLTS, NUTS AND STUDS.** Machine bolts, nuts, and studs furnished shall be of the size, length and thread specified and shall conform to the requirements of the Federal Specifications for Machine Bolts, Nuts, Studs and Tap Rivets, FF-B-571a. Unless otherwise specified the material furnished shall be Class C Steel, unfinished, either cut threads or full diameter body rolled threads with Class 1 loose fit, and bolt heads and nuts shall be square, regular weight.

**4220.03 MACHINE SCREWS.** Machine screws furnished shall be of the type of metal, size, thread, length, finish and type of head specified and shall conform to the requirements of the Federal Specifications for Screws, Machine including Set Screws FF-S-91. Unless otherwise specified machine screws will be furnished in commercial steel, bright finish, Class 2 freefit.

**4220.04 STOVE BOLTS.** Stove Bolts shall conform to requirements for machine screws, except that they shall be furnished in the size, length, type of head specified, in commercial steel, bright finish, and shall have national coarse thread, square nuts, with Class 1 loose fit.

**4220.05 ROUND UNSLOTTED HEAD BOLTS.** Round unslotted head bolts shall conform to requirements of Federal Specification FF-B-571a and to the dimensions of the American Standard B-18.5-1939. Unless otherwise specified the bolts furnished shall be square neck carriage bolts of Class C steel, unfinished, with either cut threads or full-diameter body, rolled threads, with square nuts, Class 1 loose fit.

**4220.06 CAP SCREWS.** Cap Screws furnished shall be of the size, length, thread, and type of head specified and shall conform to the requirements of Federal Specification FF-B-



571A and to the dimensions of the American Standards B-18.2-1941 for wrenchhead bolts, nuts and wrench openings, or B-18.3-1936 Socket Head Set Screws and Socket Head Cap Screws with supplement B-18.3-1944. Cap Screws with N.C. thread shall have length of thread equal to  $2 D + \frac{1}{4}$ " and Cap Screws with N.F. thread shall have length of thread  $1\frac{1}{2} D + \frac{1}{4}$ " ( $D =$  diameter of body of screw). Screws too short to be threaded to these lengths shall be threaded as close to the head as possible. For semi-finished cap screws the tolerance from the basic dimensions shall be the same as for semi-finished bolt heads. The unthreaded body diameter of cap screws will have the same tolerance as the major thread diameter shown in American Standard B-1.1-1935 where the thread and class of fit is the same. Cap screws may be furnished either semi-finished or finished and shall be of Commercial Class C Steel, with Class 2 freefit.

**4220.07 PLOW BOLTS.** Plow bolts shall be of the size and length specified and shall conform to the requirements of Federal Specification FF-B-571a and to the dimensions of American Standard B-18f-1928. Plow bolts furnished shall be round head, square neck, countersunk type, regular bolts, unfinished, with National coarse thread, square nuts with Class 1 loose fit.

**4220.08 ZINC COATED SIGN BOLTS.** All sign bolts shall be  $\frac{3}{8}$  inch diameter National coarse thread, 16 per inch, of the length specified, unfinished machine bolts, conforming to the Federal Specification FF-B-571a Class C Commercial steel, and to the dimensions of American Standard B-18.2-1941. Sign bolts shall have regular heads and nuts, rolled threads with reduced diameter body, Class 1 loose fit before receiving the zinc coating. The reduced body diameter shall conform to the requirements for pitch diameter for Class 1 fit.

After zinc coating is applied the body diameter and height of head shall not be more than 0.010 inch greater than the maximum specified for uncoated bolts. The width across flats of bolt heads and nuts shall be less than minimum wrench opening.

The nuts shall assemble with the coated bolts. The uncoated nuts shall conform to the dimensional requirements before threading or coating. Nuts shall be threaded after coating.

Each bolt shall be assembled with one  $\frac{3}{8}$ " plain washer  $\frac{13}{16}$ " outside diameter, regular thickness, and one nut.



Bolts, nuts and washers shall have a smooth uniform continuous zinc coating applied by the hot dip process at a rate of not less than one ounce per square foot on all surfaces, except internal threads. This coating shall be smooth, free from blisters, scales, holes or imperfections.

The weight of coating will be determined by the A.S.T.M. Hydrochloric Acid Antimony Chloride Method A.S.T.M. A-90.

**4220.09 LOCK WASHERS.** Lock washers furnished shall be of the size specified and shall conform to requirements of S.A.E. Standards for Carbon Steel Lock Washers including tests for temper and toughness (1946 S.A.E. Handbook).

**4220.10 PLAIN WASHERS.** Plain washers shall be of size specified and shall conform to the dimensions of the S.A.E. Standards (1946). Plain washers shall be flat and free from burrs and unless otherwise specified shall be uncoated commercial steel or wrought iron.

**4220.11 COTTER PINS.** Cotter pins furnished shall be of the diameter and length specified according to the 1946 S.A.E. Standard. They shall conform to the Federal Specifications FF-P-386 and shall be Type B steel, split cotter pins of the "extended prong" type.

**4220.12 NAILS, SPIKES, STAPLES AND TACKS.** All nails, spikes, staples, and tacks shall be of the type and size specified and shall conform to the requirements of Federal Specifications FF-N-101. Unless otherwise specified all nails, spikes, and staples shall be uncoated steel wire, smooth, bright finish and tacks shall be flat head, cut, blued finish.

**4220.13 WOOD SCREWS.** Wood Screws furnished shall have the form of head, and length specified and shall conform to the requirements of Federal Specification FF-S-111 and to the dimensions specified in American Standard B-18c-1930. Unless otherwise specified the screws shall be steel, bright finished.

**4220.14 PACKAGE AND MARKING.** All bolts, screws, nuts and washers shall be packed in strong substantial cardboard or fiber box. Each bolt shall be assembled with one nut. Each container shall be clearly marked with the following information:

Number of pieces

Type of bolt or screw



Type of heads or nuts  
 Size and length of bolt or screw  
 Thread per inch, thread series and class of fit  
 Metal and finish

All pieces in one box shall be of one size and length, one thread count and one type of head or nut.

The number of pieces per package shall conform to standard practice according to size or length of articles as follows:

Article	Quantity per Box
Bolts and nuts assembled	25-50 or 100
Machine Screws	Gross, 100 or fraction thereof
Stove Bolts	25-50 or 100
Nuts (separate)	25-50 or 100
Wood Screws	Gross, or 100 or fraction thereof
Lock Washers $\frac{1}{2}$ " & smaller	1000
Lock Washers $\frac{9}{16}$ " & larger	500
Plain Washers $\frac{1}{4}$ " & smaller	1 pound
Plain Washers $\frac{5}{16}$ " & larger	100 pounds
Cotter Pins	250-500-1000
Nails, Spikes & Staples	25-50-100-200 pounds
Tacks	1 pound or fraction thereof

**4220.15 INSPECTION AND TESTS.** Inspection will usually be performed after delivery of the material but the Engineer may elect to have the material inspected or sampled at the manufacturer plant. The Engineer or his representative shall have free access to the plant for this inspection and every facility shall be extended to him for this purpose.

If any material fails to meet the specified requirements, a retest may be made on twice the number of specimens taken from other packages in the same lot. If all these check specimens shall meet the requirements the lot will be accepted. If check samples also show the material does not meet the requirements the lot will be rejected.

The inclusion of any material which has been previously rejected in a later lot presented for inspection will be deemed sufficient cause for rejection of the entire lot without inspection.

All materials will be inspected for compliance with requirements for material and dimensions. Tests made on the various categories of articles shall include the following:



A. **Bolts and Screws.** Not less than 1 tension and one bend test shall be made on each lot of each diameter of bolts or screws.

The Class C Steel shall show an ultimate tensile strength of not less than 48,000 lb. per square inch.

B. **Nuts.** In lieu of the cold-flattening test specified in the Federal Specifications nuts may be required to withstand decrease in overall diameter or width between flats by an amount equal to 10% of the nominal bolt diameter without visible cracks on inside or outside of the nut.

This flattening may be done by steadily pressing the nut in a vise or testing machine until the specific reduction has been made. The castellated part of castellated nuts shall not be removed for this test.

C. **Plain and Lock Washers.** For the purpose of inspection, plain washers will be divided into lots of not more than 100 pounds of each size. From each lot not less than 6 specimens shall be selected at random for inspection and testing. Plain washers shall be inspected for dimensions, flatness and freedom from burrs. Lock washers shall be inspected for dimensions and tested for hardness, temper and toughness.

D. **Cotter Pins.** For the purpose of inspection cotter pins shall be divided into lots of not more than 1000 pieces of one size and type. From each such lot not less than 6 specimens will be selected at random for inspection and testing.

**4220.16 METHOD OF MEASUREMENT.** The quantity of each of the various categories of hardware delivered, which conform with the foregoing requirements, will be determined by the Engineer from count of packages and count or weight of contents.

**4220.17 BASIS OF PAYMENT.** For the quantity of each of the various categories of hardware of acceptable quality and measured as specified above, the Contractor will be paid the contract unit price. These unit prices shall be full compensation for furnishing all material and delivering it with freight prepaid to the specified destination.



## Section 4221. Cutting Edges

**4221.01 GENERAL.** Cutting edges furnished shall be of two types known as drag blades and grader blades.

Drag blades shall be flat, chamfered on the back side of the upper edge and neither polished nor sharpened.

Grader blades shall be concave toward the front, chamfered on both edges on the back and polished on the front. They shall conform to the following requirements:

- A. Dimensions.** Drag blades shall be  $\frac{1}{2}$  inch thick by 8" wide. Grader blades shall be  $\frac{1}{2}$ " thick by 6" wide. The width of chamfer shall not be less than  $\frac{7}{8}$  inch nor more than 1  $\frac{1}{16}$  inch. The Thickness of the chamfered edge shall not be less than  $\frac{1}{16}$ " nor more than  $\frac{3}{16}$ ". All blades shall be punched in accordance with Standards adopted by the A.A.S.H.O. Holes shall be punched accurately within  $\frac{1}{16}$ " of the correct line and distance.
- B. Chemical Composition.** Chemical analysis of the metal of the blades shall show the following elements within the limits specified:

	Minimum %	Maximum %
Carbon .....	0.80	1.00
Manganese .....	0.50	0.90
Sulphur .....		0.05
Phosphorus .....		0.05
Silicon .....		0.30

- C. Hardness.** The average Brinell Hardness number for any lot of finished blades shall not be less than 275 nor more than 350. The average of three hardness numbers for any individual blade shall not be less than 260 nor more than 370. No spot on any blade shall show a hardness number less than 250 or more than 385.
- D. Weight.** The average weight per lineal foot of any lot of blades shall be within the following limits:

	Weight per Foot (Pounds)	
	Minimum	Maximum
Drag Blades .....	12.50	13.25
Grader Blades .....	8.50	9.00

**4221.02 INSPECTION.** Unless otherwise provided all cutting edges will be inspected after delivery at the destination specified.

**4221.03 SHIPMENT.** All cutting edges will be shipped in box cars with freight prepaid to the specified destination.



**4221.04 METHOD OF MEASUREMENT.** The net weight of cutting edges delivered will be determined by the Engineer from railroad weights of car load shipments, or by weighing after delivery less than carload shipments.

**4221.05 BASIS OF PAYMENT.** For the weight of drag blades and grader blades furnished, conforming to the foregoing requirements, the Contractor will be paid the contract price per pound except that the total weight paid for shall not exceed the maximum weight per foot specified for the respective types in Paragraph 4221.01D. This price shall be full compensation for furnishing, fabricating and delivering the blades, with freight prepaid to the specified destination.

## Section 4222. Tie and Brace Wires

**4222.01 GENERAL.** Tie and brace wire for installation of snow fence shall be black annealed steel wire conforming with the following requirements:

A. **Size.** The size of wire furnished shall be within the following limits:

	Gage	(Diam. Inches)	Tolerance Inches
Tie Wires .....	14	0.083	± .003
Brace Wire .....	13	0.0915	± .003

Wire ties shall be 11 inches in length over all and shall have a loop at each end. The inside diameter of the loops shall not be less than  $\frac{3}{8}$  inch nor more than  $\frac{1}{2}$  inch.

B. **Strength.** The wires shall show a tensile strength of 45,000 to 60,000 pounds per square inch.

C. **Twists.** The wire shall stand without fracture not less than 50 twists in a length equivalent to one hundred diameters. This test shall be made on a standard torsion machine or equivalent with one head of the machine rotating and the opposite head non-rotating but movable horizontally. The tension applied by the movable head shall be less than 25 lb. and the rate of rotation shall be 20-25 twists per minute.

**4222.02 PACKAGE.** Brace wire shall be packaged in coils of 100 lb. each and shall be securely tied in at least four points.

Wire ties shall be threaded on a wire through each loop to form a bundle of 5,000 ties each which shall be securely tied.



**4222.03 METHOD OF MEASUREMENT.** The amount of brace wire furnished will be determined from the count of the coils and net weight of shipment at point of delivery.

The number of wire ties will be determined from the count of the bundles, the net weight, and the weight of a hundred ties selected at random.

**4222.04 BASIS OF PAYMENT.** For net weight of brace wire furnished in accordance with the foregoing provisions the Contractor will be paid the contract price therefor.

For the number of bundles of wire ties furnished in accordance with the foregoing provisions the Contractor will be paid the contract price therefor.

These prices shall be full compensation for furnishing the material, with freight prepaid for destinations specified in the contract.

### Section 4223. Mower Parts

**4223.01 GENERAL.** Mower parts shall fit accurately and be interchangeable with parts manufactured by the makers of the mowers for which they are intended as indicated by the manufacturer's part number specified. Unless specifically called for in the instruction to bidders castings shall not be furnished for parts for which the manufacturer furnishes forgings.

**4223.02 SICKLE SECTIONS.** Sickle sections shall have an average Rockwell Hardness of not less than C-50 near their cutting edges and not more than C-35 in the body of the section. The sections shall have average thickness not less than the following when measured  $\frac{3}{8}$  inch in from the rolled edge of the part:

Make of Mower	Original Part No. (For Identification only)	Min. Ave. Thickness	Individual Minimum Thickness
Oliver (Reg.)	Z-5473	0.077 in.	0.075 in.
Oliver (Heavy Duty)	Z-5736 and Z-5737	0.114 in.	0.112 in.
Oliver	Z-5738 and Z-5739	0.114 in.	0.112 in.
McCormick-Deering	M-333 $\frac{1}{2}$ and M-22831	0.114 in.	0.112 in.
John Deere	Z-6451 and Z-7030	0.103 in.	0.101 in.
J. I. Case	MT-590-S and MT-944-S	0.103 in.	0.101 in.



Smooth and underserrated sections shall both conform to the above general specifications.

For serrated sections, the depth of serration and the number of serrations per inch shall not be less than that on the genuine sections.

**4223.03 GUARD PLATES.** Guard plates shall have an average Rockwell hardness of not less than C-30 near their cutting edges. The plates shall have an average thickness of not less than the following when measured  $\frac{3}{8}$  inch in from the rolled edge of the part:

Make of Mower	Original Part No. (For Identification Only)	Minimum Average Thickness	Individual Minimum Thickness
Oliver.....	Z-5164, Z-5474 Z-5163	0.103 in.	0.101 in.
McCormick-Deering.....	MA-990	0.103 in.	0.101 in.
John Deere.....	Z-5110 & Z-5204	0.114 in.	0.112 in.
Detroit.....	017	0.103 in.	0.101 in.
J. I. Case.....	011565-S	0.103 in.	0.101 in.

**4223.04 SICKLE GUARDS.** Sickle guards shall conform in size and shape to the part as indicated by the genuine part number. They shall be furnished equipped with guard plates conforming to requirements of Article 4223.03. The average weight of the guards complete shall not be less than the following:

Make of Mower	Original Part No. (For Identification Only)	Minimum Average Weight-Pounds
Oliver.....	Z-181X	1.11
Oliver.....	Z-156	1.20
McCormick-Deering.....	M-2041	1.30
John Deere (Forging).....	AZ-2191	1.40
John Deere (Forging).....	AZ-2132	1.35
John Deere (Malleable Iron).....	Z-591	1.32
John Deere (Casting).....	Z-592	1.28
Detroit.....	012	1.18
J. I. Case.....	MTB-154	1.15
J. I. Case.....	MTB-155	1.14

**4223.05 SICKLES.** Sickles shall be genuine or shall fit accurately and be interchangeable with parts manufactured by the maker of the mowers. Sickle sections taken from the sickle shall comply with requirements of Article 4223.02.



**4223.06 BOLTS.** The bolt head and nut must be genuine or be identical in pattern and dimensions with the genuine. The thread shall be Class 2 fit as established by the National Screw Thread Commission. The threads may be either cut or full diameter rolled threads.

**4223.07 MATERIALS.** Mower parts made from various materials shall comply with the following specifications:

- A. **Forgings.** Forgings shall be made from metal conforming to the A.S.T.M. Specifications for Carbon Steel Blooms, Billets and Slabs for Forgings, designation A-273.
- B. **Malleable Iron Castings.** Malleable iron castings shall conform to the requirements of the A.S.T.M. Standard Specifications for Malleable Iron Castings, Designation A-47.
- C. **Carbon Steel Castings.** Carbon steel castings shall conform to the requirements of the A.S.T.M. Tentative Specifications for Carbon Steel Castings for Miscellaneous Industrial Users, Designation A-27 for grade A-2 (normalized) or Grade A-3 (annealed) castings.

**4223.08 METHODS OF SAMPLING AND INSPECTION.**

Each shipment shall be sampled after delivery. From each lot of sickle sections or guard plates a sample shall be selected of each kind of part. This sample shall consist of 1% of the total number of pieces to be represented by the sample. Each of the pieces in each sample shall be tested. The hardness of sickle sections shall be determined at three points near the cutting edges and at two points in the body of the section. The points near the cutting edges shall be located as follows: One point midway between the two cutting edges and  $\frac{3}{8}$  inch from the point of the section; two points on opposite edges of the section  $\frac{3}{8}$  inch from the cutting edge and  $1\frac{1}{4}$  inches from the point of the section. The two points in the body of the section shall be located as follows: One point midway between the two edges of the section and  $\frac{3}{8}$  inch from the heel of the section; one point at the center of the section in both directions.

The hardness of the guard plates shall be determined at three points located as follows: One point midway between the two cutting edges and  $\frac{1}{2}$  inch from the front end of the plate; two points  $\frac{1}{4}$  inch from cutting edges and 1 inch from the front end of the plate.

The Rockwell Hardness determinations for the three points



near the cutting edge of each sickle tested shall be averaged and the hardness determinations for the two points in the body of the section shall be averaged. The hardness determinations for the three points of each guard plate tested shall be averaged.

At least 90% of all specimens of any sample of sickle sections or in any sample of guard plates shall meet the specified requirements.

The weight of the sickle guards shall be determined by weighing at least 10% of the total number of guards in any lot of a single kind of guards.

**4223.09 PACKAGING.** The sickle sections and guard plates shall be packed in strong cardboard boxes and each box shall be plainly marked showing the make of machine for which it is intended, the name of the part, the genuine part number and the number in the box.

The guards shall be packaged in lots of 100 in strong wooden boxes and each box shall be plainly marked, giving the corresponding information as specified for sections and guard plates.

Bolts and nuts shall be packaged 25 bolts and 25 nuts in each strong cardboard box. Each box shall be clearly marked with the make of machine for which it is intended to be used, the name of the part, the genuine part number, diameter, length and number of threads per inch, and the number in the box.

Rivets shall be packaged in substantial wood boxes, kegs or heavy cardboard cartons with iron bands. The quantity per package shall be not less than 50 nor more than 150 lbs. Each package shall be clearly marked with make of machine for which it is intended to be used, the name of the part, size and length of rivet and net weight in pounds.

**4223.10 METHOD OF MEASUREMENT.** The quantity of sickle sections, guard plates, sickle guards, sickles and bolts delivered and accepted under these specifications will be determined by the Engineer by count of packages and contents. The quantity of rivets delivered will be determined by net weight of shipment.

**4223.11 BASIS OF PAYMENT.** For the quantity of the various mower parts delivered and accepted under these specifications the Contractor will be paid the contract price therefore. This price shall be full compensation for furnishing all ma-



terial, preparing and shipping the various items with transportation prepaid to the specified destination.

### Section 4224. Steel Sign Posts

**4224.01 GENERAL.** Steel angle sign posts shall be furnished in the length specified. They shall be made of hot rolled steel angles 2"x2"x3/16" and shall weigh approximately 2.44 lb. per foot of length. One leg of the angle shall be punched with 8 holes, 7/16" in diameter, located on the centerline of the leg, first hole 3 inches from end and seven more holes 6" cc. Spacing and alignment shall be within 1/16 inch of the true center lines and distance.

**A. Spelter Coating.** After posts are cut to length and punched they shall be given a coating of spelter by the hot dip process. The coating shall be smooth and uniform, free from blister spots, scales, holes, or other imperfections and shall be applied at a rate of not less than 2 ounces per square foot of surface. Determination of weight of coating shall be made in accordance with A.A.S.H.O. Standard Method T-65.

**4224.02 MEASUREMENT AND PAYMENT.** For the number of acceptable posts delivered, in accordance with the foregoing provisions, the Contractor will be paid the contract price per post. This price shall be full compensation for furnishing the material, fabrication, spelter coating, and delivery of the posts, with freight prepaid to the specified destination.

### Section 4225. Steel Snow Fence Posts.

**4225.01 GENERAL.** Steel posts for snow fences shall be rolled from rail steel or hard grade new billet stock. They shall be "T" section 1½"x1½" or other approved section. The posts shall be not less than 6½ feet in length. The average weight of the "T" section posts shall be not less than 1.33 lb. per foot and no single post shall weigh less than 1.29 lb. per foot. Posts shall be sharpened by shearing off both flanges of the "T" at an angle approximately 45°. Posts shall be punched with one ¾ inch hole near the top.

**A. Alternate Sections.** Posts other than the foregoing "T" section shall be 6½ feet long and shall have a depth of section perpendicular to the face to which the fence is to be attached, not less than 1½ inches exclusive of deformations. The moment of inertia of the section



about the axis parallel to the face of the post shall not be less than 0.75 (inches<sup>2</sup>). These posts shall be sharpened and punched in a manner similar to that specified for "T" section posts.

B. **Painting.** All posts after shearing and punching shall be painted with an iron oxide paint, oven dried in such a way that the film will be uniform hard and free from marks due to contact with other surfaces during drying. The paint shall have flowing and covering properties suitable to the method of application. It shall contain not less than 40.0 percent by weight of iron oxide pigment and shall weigh not less than 10.0 pounds per gallon at the time of application.

**4225.02 MEASUREMENT AND PAYMENT.** For the number of posts of acceptable quality delivered the Contractor will be paid the contract price per post. This price shall be full compensation for furnishing all materials, fabrication, painting and delivering the posts to the specified destination, with freight prepaid.

### Section 4230. Snow Fence

**4230.01 GENERAL.** Snow fence shall consist of wood slats tightly woven together with galvanized wire cables in accordance with the following provisions. The space between slats shall not be more than 2 inches.

**4230.02 SLATS.** Slats shall be either southern pine or Douglas Fir. The actual dimensions of the slats when the fence is delivered shall not be less than  $\frac{1}{2} \times 1\frac{1}{2}$  inches.

Slats shall be free from wane. Slats shall be cut with square ends to a length of  $47\frac{1}{2}$  to  $48\frac{1}{2}$  inches, and shall be well seasoned before weaving. Not more than 3% of the slats in any roll of fence shall be weak because of cross grain, knots or other defects.

**4230.03 CABLES.** The slats shall be tightly woven together by 4 or 5 cables, each cable to consist of two galvanized wires. If four cables are used the wire shall not be less than 0.102" in diameter. If five cables are used the wire shall not be less than 0.095 inches in diameter. One cable shall be placed approximately 4" from each end of the slats and the other cables equally spaced between these two. Each wire shall have a continuous coating of zinc of uniform thickness.



The average amount of coating shall be not less than 0.50 ounce per square foot. No one specimen shall show less than 0.45 ounce per square foot of surface. Such limits shall apply to wire before fabrication. The coating shall be smooth and free from blister spots, scales, holes or other imperfections, and shall not crack or spall when the wire is fabricated into snow fence.

**4230.04 SAMPLING AND TESTING.** Samples shall be taken from at least 10% of the number of bundles of wire or snow fence in a shipment, each sample to consist of not less than 12" of wire, and not less than 12 wires shall be tested as the basis of computing the average amount of coating. The weight of coating shall be determined by the A.S.T.M. "Standard Method of Determining Weight and Uniformity of Coating on Zinc-Coated Iron and Steel Articles," Designation A-90.

**4230.05 PAINT.** All fence shall be treated as manufactured by passing it through a red iron oxide paint. Such paint shall thoroughly cover the slats.

**4230.06 PACKING.** The fence shall be furnished in rolls containing 50 feet of fence, unless otherwise specified.

**4230.07 MEASUREMENT AND PAYMENT.** The Engineer will determine the quantity of snow fence delivered. For the quantity of snow fence of satisfactory quality delivered to the specified destination the Contractor will be paid the contract price per foot. This price shall be full compensation for furnishing all material for fabrication, painting and delivery of the fence, with the freight prepaid to the specified destination.

### Section 4231. Wood Sign Posts

**4231.01 GENERAL.** Wood sign posts may be furnished in treated Southern Pine or Douglas Fir, or untreated in Redwood as specified in the contract.

**A. Species.** The posts of the various species shall conform to the following requirements:

**1. Redwood.**

**a. Size of Knots.** Knots shall not exceed one-third of the width of face. Single pin knots will be admitted in any position except in clusters. The number of sound, incased or pith knots on all 4 sides of the



piece shall not exceed twice the length of the stick in feet and the total number of knots on any one face shall not exceed three-fourths of the length of the stick in feet. Clusters of knots will not be admitted.

b. **Shakes, Checks and Splits.** Shakes, checks and splits in green wood shall not exceed  $\frac{1}{2}$  the width of the end. In seasoned wood they shall not exceed  $\frac{3}{5}$  the width of the end.

c. **Slope of Grain.** In the middle  $\frac{1}{3}$  of the length, the slope of grain shall not exceed one to 15.

d. **Heartwood.** Pieces shall contain only Heartwood.

e. **Close Grain.** Rate of growth shall not be less than 7 annual rings per inch.

2. **Southern Pine.** Southern Pine Posts shall comply with the requirements for "No 1 Longleaf Small Timbers" or "No. 1 Shortleaf Small Timbers" as given in the Southern Pine Association "Standard Specifications for Southern Pine Lumber and Timber," effective July 1, 1939, except that in the center half of the length the sum of the diameters of all knots on any one face shall not exceed the width of the face.

3. **Douglas Fir.** Douglas Fir posts shall comply with the requirements of Paragraphs 204 and 229 of the Standard Grading and Dressing Rules of the West Coast Bureau of Lumber Grades and Inspection, "No. 14 effective Aug. 1, 1947, except in the center half of the length the sum of the diameters of all knots in any one face shall not exceed the width of the face.

B. **Size.** All wood sign posts shall be furnished to the nominal dimension of 4 in. x 4 in. surfaced 4 sides to not less than  $3\frac{1}{2}$  in. x  $3\frac{1}{2}$  in., in lengths 8 ft., 10 ft., 12 ft., as ordered. All posts shall be sawed square at both ends and shall be bored with 8 holes  $\frac{7}{16}$  in. diameter. The first hole shall be 3 in. from one end and other holes at 6 inch spacing (cc). The spacing and alignment of the holes shall be within  $\frac{1}{16}$  inch of true centerline and distance.

C. **Preservative Treatment.** All Douglas Fir and Southern Pine sign posts shall be given full pressure preservative treatment with creosote in accordance with the method



specified in Section 4137, "Preservative Treatment for Timber".

D. **Inspection.** Inspection of untreated wood posts will be made after delivery.

Inspection of treated wood posts will be performed at the treating plant. Both the untreated material and the treating process will be inspected. The manufacturer shall advise the Department of Materials and Tests a sufficient time in advance of the treating date to allow for arrangements for inspection and testing preliminary samples of preservatives.

**4231.02 MEASUREMENT AND PAYMENT.** The Engineer will determine the number of sign posts of the various species and lengths delivered. For the number of posts conforming with the foregoing requirements delivered to the specified destination the Contractor will be paid the contract price per post. This price shall be full compensation for furnishing all materials, for fabrication, for treatment and delivery with freight prepaid to the specified destinations.

### Section 4240. Concrete for Pavement Repair

**4240.01 GENERAL.** Concrete for pavement repair shall conform to the requirements of Articles 2403.04 to 2403.09 inclusive for Concrete Masonry and to the following provisions.

**4240.02 MATERIALS.** Materials for concrete for pavement repair shall conform to the requirements of Part 4 for the respective materials.

**4240.03 PROPORTIONS.** Materials for concrete for pavement repair shall be mixed in one of the following proportions specified in the contract.

Mix. No.	Basic Absolute Volumes per Unit Volume of Concrete			
	Cement Minimum	Water Approximate	Fine Aggregate Approximate	Coarse Aggregate Approximate
1 M	0.151121	0.168436	0.238155	0.442287
2 M	0.152486	0.169958	0.271023	0.406533
3 M	0.153876	0.171508	0.303577	0.371039
4 M	0.155293	0.173085	0.335811	0.335811
	Cement Minimum	Water Approximate	Aggregate Approximate	Air Voids Approximate
Cl. V M	.161533	.162038	.621430	0.054999



A. **Water.** The total volume of free water in the concrete including the water in the aggregate shall not exceed 3.7 gallons of water per bag of cement (0.328 lb. per lb.) when Class V aggregate is used and shall not exceed 4.1 gallons of water per bag of cement (0.364 lb. per lb.) when other aggregates are used.

B. **Quantities.**

Mix No.	Approximate Quantities of Dry Material Per Cubic Yard of Concrete			
	Cement		Fine Aggregate	Coarse Aggregate
	Bags	Pounds	Pounds	Pounds
1 M	8.56	799	1063	1975
2 M	8.58	807	1210	1815
3 M	8.66	814	1355	1657
4 M	8.74	822	1499	1499
Cl. V M	9.09	855		2743

These quantities are based on the following assumptions:

Specific gravity of cement.....	3.14
Specific gravity of aggregates	
Class V .....	2.62
Other Aggregates .....	2.65
Water Cement Ratio, gallons per bag	
With Class V aggregate.....	3.6
With Other Aggregates.....	4.0
Weight of one cubic foot water.....	62.4 lb.

That the concrete contains no air voids except 5.5% with Class V aggregate.

C. **Specific Gravity Correction.** Should the specific gravity of aggregates used in the mixture vary from those used in the estimate, the quantity of materials per batch will be adjusted to yield the estimated solid volume of aggregate.

D. **Consistency.** The amount of mixing water used shall be adjusted to produce concrete of a uniform consistency of not more than 1.0 inch slump determined in accordance with ASTM Method C-143.

**4240.04 DELIVERY.** The Contractor shall deliver the mixed concrete into transporting vehicles of the County at the mixing plant or deliver the mixed concrete in his own vehicles to the site of the work as specified in the contract. When concrete is transported in vehicles of the Contractor the ve-



hicles and the operation shall conform to the requirements for Ready Mixed Concrete, Article 2301.18.

**4240.05 METHOD OF MEASUREMENT.** The quantity of mixed concrete furnished will be computed by the Engineer from the absolute volumes of dry materials and water entering the average batch.

When the contract requires delivery of the concrete by the Contractor to the site of the work, the Engineer will compute the yard-miles of haul to the nearest  $\frac{1}{4}$  miles for each cubic yard of concrete to the nearest  $\frac{1}{4}$  yard along the shortest practical route.

**4240.06 BASIS OF PAYMENT.** For the number of cubic yards of concrete of acceptable quality measured as provided above, delivered to the specified destination, the Contractor will be paid the contract price per cubic yard. For the number of yard-miles of haul computed as provided above the Contractor will be paid the contract price per yard-mile. These unit prices shall be full compensation for furnishing all materials and labor, for proportioning, mixing and delivering the concrete to the specified destination.

### Section 4250. Diesel Fuel

**4250.01 GENERAL.** The diesel fuel shall be a completely distilled mineral oil conforming to the following requirements:

A. Saybolt Universal Viscosity,	
Seconds @ 100°F.....	Minimum 33
B. Sediment and Water (By Volume).....	Maximum 0.05%
C. Conradson Carbon Residue*.....	Maximum 0.20%
D. Ash (By Weight).....	Maximum 0.01%
E. Flash Point .....	Minimum 150°F.
F. Sulphur .....	Maximum 0.80%
G. Cetane Number .....	Minimum 45

**4250.02 DELIVERY.** Diesel fuel will be delivered by tank truck from the bulk plant designated in the bid to the storage tanks of the maintenance garage of the County as designated in the contract.

**4250.03 SAMPLING AND TESTING.** The various shipments of diesel fuel will be sampled at time of delivery and

\*Conradson residuum to be determined on final 10% distillation.



samples submitted to the Ames Laboratory for testing. All tests will be performed in accordance with the methods adopted by the ASTM for the test indicated. The Contractor will be notified promptly of results of such tests. Failure to deliver diesel fuel complying fully with these specified requirements will be deemed sufficient cause for cancellation of the contract in whole or in any part from which unsatisfactory diesel fuel has been received.

**4250.04 METHOD OF MEASUREMENT.** The quantity of diesel fuel of acceptable quality delivered to the specified destination will be measured in U. S. Standard Gallons by gaging the storage tank or by metering the fuel at time of delivery.

**4250.05 BASIS OF PAYMENT.** For the quantity of diesel fuel of acceptable quality delivered, the Contractor will be paid the contract price per gallon. This unit price shall be full compensation for furnishing the diesel fuel and delivery of it to the storage tanks at the specified destination.

### Section 4251. Gasoline

**4251.01 GENERAL.** This specification covers the grade of gasoline generally used as a fuel for automobiles, trucks, and tractors. Gasoline purchased under this specification shall comply with the following requirements:

- A. **A. P. I. Gravity.** The A. P. I. gravity at 60°F./60°F. shall not be less than 58.0.
- B. **Sulphur.** Sulphur shall not be over 0.10 per cent.
- C. **Gum.** The gum content shall not exceed 7 milligrams per 100 cubic centimeters of gasoline. Gasoline containing a non-volatile material such as a solvent oil shall be tested by methods satisfactory to the marketers of such products and the County.
- D. **Vapor Pressure.** During the months of May, June, July, August, September, the vapor pressure at 100°F. shall not exceed 9.0 pounds per square inch. During the months of October, November, December, January, February, March, and April, the vapor pressure at 100°F. shall not exceed 15.0 pounds per square inch.
- E. **Octane Number.** The gasoline shall have an octane number not less than 73 (A.S.T.M. Motor Method).



**F. Distillation Range.** When the first drop falls from the end of the condensor, the thermometer shall not read more than 55°C. (131°F.)

When 10% has been recovered in the receiver, the thermometer shall not read more than 80°C. (176°F.) nor less than 50°C. (122°F.), provided that for each per cent distillation loss less than 4% obtained in the distillation, the minimum 10% temperature requirements shall be lowered 3°C. (5.4°F.).

When 20% has been recovered in the receiver, the thermometer shall not read more than 105°C. (221°F.).

When 50% has been recovered in the receiver, the thermometer shall not read more than 140°C. (284°F.).

When 90% has been recovered in the receiver, the thermometer shall not read more than 200°C. (392°F.).

The end point shall not be higher than 225°C. (437°F.).

At least 95% shall be recovered as distillate in the receiver from distillation.

**4251.02 DELIVERY.** Gasoline will be delivered by tank truck from the bulk plant designated in the bid to the storage tanks of the maintenance garage of the County as designated in the contract.

**4251.03 SAMPLING AND TESTING.** The various shipments of gasoline will be sampled at time of delivery and samples submitted to the Ames Laboratory for testing. All tests will be made in accordance with the method adopted by the A.S.T.M. for the test indicated. The Contractor will be notified promptly of the results of such tests. Failure to deliver gasoline complying fully with the specified requirements will be deemed sufficient cause for cancellation of the contract either in whole or in that part from which unsatisfactory gasoline has been received.

**4251.04 METHOD OF MEASUREMENT.** The quantity of gasoline of acceptable quality delivered to the specified destination will be measured in Standard U. S. Gallons by gaging the storage tanks or by metering the fuel at time of delivery.

**4251.05 BASIS OF PAYMENT.** For the quantity of gasoline of acceptable quality delivered, the Contractor will be paid the contract price per gallon. This unit price shall be full compensation for furnishing the gasoline and delivering it to the storage tanks of the County at the specified destination.



## Section 4252. Greases

**4252.01 GENERAL.** This specification is intended to cover the grades of greases used for the lubrication of such parts of automotive equipment, tractors, and other machinery used in highway work as are lubricated by means of compression cups, pressure fittings, or other suitable systems.

The greases covered by these specifications shall be homogeneous combinations of mineral oil and calcium or sodium soap. They shall be free of all fillers or any other materials not naturally occurring in soaps and oils, unless required by the specifications. The use of rework grease in the compounding of greases to meet these specifications will not be permitted.

The greases shall have only a slight odor of mineral oil, shall not be perfumed, and shall be free of disagreeable odor or rancidity. Greases containing vegetable fats and oils will not be acceptable.

Six types of greases shall be supplied and designated as follows:

- Pressure Gun
- Graphite Water Pump
- Light Internal Gear
- Heavy Internal Gear
- Universal Joint and Wheel Bearing
- Outside Gear and Cable Coating Compound

**4252.02 PRESSURE GUN GREASE.** Pressure gun grease shall be prepared from mineral oil and soap in accordance with the following requirements:

A. Soap. The soap used in compounding the pressure gun grease shall be made from Prime No. 2 beef tallow, and/or triple-pressed stearic acid, and lime. The lime used in preparing the soap shall contain not more than 3% of magnesium oxide and not more than 1% of gritty, non-soap forming substances.

B. Properties of Mineral Oil.

Saybolt Viscosity, Sec. @ 210°F. ....	80 to 90
Pour Test, Maximum .....	10°F.
Color, not darker than .....	Light Green

C. Properties of the Finished Grease.

ASTM Worked Penetration @ 77°F. ....	290 to 320
Mineral Oil Content, Minimum .....	88.0%
Water, Maximum .....	1.0%



## Neutralization:

Acid as Oleic, Maximum .....	0.1%
Alkali as Calcium Oxide, Maximum .....	0.2%
Ash, Maximum .....	1.9%

**4252.03 GRAPHITE WATER PUMP GREASE.** Graphite water pump grease shall be prepared from soap, graphite and mineral oil in accordance with the following requirements:

A. Soap. The soap used in making this grease shall be made from Prime No. 2 beef tallow and/or triple-pressed stearic acid and lime. The lime used in preparing the soap shall contain not more than 3% magnesium oxide and not more than 1% of gritty, non-soap forming substances.

B. Graphite Filler. The graphite used in the grease shall consist of 20% powdered and 80% flake graphite. The ash content of the graphite shall not exceed 0.5%.

## C. Properties of the Mineral Oil.

Saybolt Viscosity @ 210° F. Sec. ....	50 to 52
Pour Test, Maximum .....	10°F.
Color, Not Darker than .....	Light Green

## D. Properties of the Finished Grease.

ASTM Worked Penetration @ 77°F. ....	175 to 205
Mineral Oil Content, Minimum .....	72.0%
Water, Maximum .....	2.0%

## Neutralization:

Acid as Oleic Acid, Maximum .....	0.1%
Alkali as Calcium Oxide, Maximum .....	0.2%
Graphite .....	3.0 to 3.2%
Dropping Point, Minimum .....	212°F.

**4252.04 UNIVERSAL JOINT AND WHEEL BEARING GREASE.** Grease for universal joints and wheel bearings shall be prepared from soap and mineral oil in accordance with the following provisions:

A. Soap. The soap used in compounding this grease shall be made from Prime No. 2 beef tallow and/or triple-pressed stearic acid and sodium hydroxide.

## B. Properties of the Mineral Oil.

Saybolt Viscosity, Sec. @ 210°F. ....	80 to 90
Pour Test, Maximum .....	5°F.
N. P. A. Color, not darker than No. ....	7



## C. Properties of the Finished Grease.

ASTM Worked Penetration at 77°F. ....	265 to 295
Mineral Oil Content, Minimum .....	88.0%
Water, Maximum .....	0.20%
Neutralization:	
Acid as Oleic Acid, Maximum .....	0.10%
Alkali as Sodium Hydroxide, Maximum .....	0.20%
Dropping Point, Minimum .....	300°F.
Fibre Length .....	Long

**4252.05 INTERNAL GEAR GREASES.** Internal gear greases shall be prepared from soap and mineral oil to produce the consistency specified in accordance with the following provisions:

A. Soap. The soap used in compounding these greases shall be made from Prime No. 2 beef tallow and/or triple-pressed stearic acid and sodium hydroxide.

## B. Properties of the Mineral Oil.

Saybolt Viscosity at 210°F.:	Light Grade	Heavy Grade
Minimum, Seconds .....	90	140
Maximum, Seconds .....	100	150
Pour Point, Maximum °F. ....	10	25
Color, Not darker than .....	Light Green	

C. Consistency. The consistency of each grade shall be adjusted so as to be adaptable for the following uses:

1. The light internal gear grease shall be satisfactory for use in light duty equipment transmissions, differentials, and other internal gears. It shall show no indication of channeling at  $-5^{\circ}\text{F}$ .
2. The heavy internal gear grease shall be satisfactory for use in heavy duty transmissions, differentials and other internal gears. It shall show no indication of channeling at  $15^{\circ}\text{F}$ .

## D. Properties of the Finished Greases.

Mineral Oil Content, Minimum .....	90.0%
Water, Maximum .....	0.30%
Neutralization:	
Acid as Oleic Acid, Maximum .....	0.20%
Alkali as Sodium Hydroxide, Maximum .....	0.30%
Fibre Length .....	Long

**4252.06 OUTSIDE GEAR AND CABLE COATING COMPOUND.** The compound shall be a mixture of petroleum pitch and rosin oil. The compound shall be of a tacky nature suitable



for lubricating exposed gears and cables. It shall have a Saybolt Furol Viscosity at 210°F. of between 180 and 200 seconds.

**4252.07 METHODS OF TESTING.** All tests shall be made in accordance with the latest methods adopted by the American Society for Testing Materials for the test indicated.

**4252.08 INSPECTION.** All grease furnished will be inspected and tested at the manufacturing plant or after delivery as the Engineer may elect. The manufacturer shall submit samples of the materials he proposes to use in compounding the greases. In the event the manufacture of the grease is inspected at the plant the inspector shall have free access to all parts of the plant and every facility shall be extended to him for this purpose.

**4252.09 PACKAGES AND MARKINGS.** All containers in which grease is packed shall be metal pails or drums, free from leaks, and clean and dry at time of filling. The various greases shall be packed in containers of the following sizes:

	Size of Container Net Weight Pounds
Graphite Water Pump .....	5
Universal Joint and Wheel Bearing.....	5
Pressure Gun .....	25
Light Internal Gear .....	25
Heavy Internal Gear .....	25
Outside Gear and Cable .....	25

Each container shall be clearly marked with a waterproof ink or paint by stenciling on the side of the container the type of grease and the quantity packaged.

**4252.10 METHOD OF MEASUREMENT.** The quantity of each of the various types of grease delivered to the specified destination will be determined from the net weight of the packages.

**4252.11 BASIS OF PAYMENT.** For the net weight of grease of each of the various types delivered complying with specified requirements the Contractor will be paid the contract price per pound. These unit prices shall be full compensation for furnishing all materials, for preparing the grease, and delivering it with freight prepaid to the specified destination.



## Section 4253. Hydraulic Hoist Oil

**4253.01 GENERAL.** This specification covers two grades of refined petroleum used as the fluid of hydraulic hoists. Compound oils containing products other than those derived from petroleum will not be considered. The oils shall be supplied in two grades designated as Grade S (Summer) and Grade W (Winter).

If a rust inhibitor is to be blended with the above oils it shall be specifically approved by the Engineer and shall be compatible with the types of oil used. The test limits for the respective grades shall apply to the oil before treatment.

**4253.02 GRADE W.** Grade W hydraulic hoist oil shall be prepared without the use of pour point depressors and shall conform to the following requirements:

Saybolt Viscosity at 100°F. Seconds .....	100 - 110
Flash Point °F., Minimum .....	325
Pour Point °F., Maximum .....	-40
NPA Color, not darker than .....	2½

**4253.03 GRADE S.** Grade S hydraulic hoist oil shall meet the following requirements:

Saybolt Viscosity at 100°F. Seconds .....	200 - 220
Flash Point °F., Minimum .....	370
Pour Point °F., Maximum .....	0
NPA Color, not darker than .....	3

**4253.04 METHODS OF TESTING.** All tests shall be made in accordance with the latest methods adopted by the ASTM for the test indicated.

**4253.05 INSPECTION.** Hydraulic hoist oil will be inspected and tested at the blending plant or after delivery as the Engineer may elect. In the event that the blending of hydraulic hoist oil is inspected at the plant, the Engineer shall have free access to all parts of the plant and every facility shall be extended to him for this purpose.

**4253.06 CONTAINERS.** Containers used for hydraulic hoist oil shall be 5 gallon or 55 gallon capacity as specified. The 5 gallon containers may be uncrated, square, tinned or tern-plated iron or steel containers with single 1½" opening with twist cap closure and wire handle. The 55 gallon containers shall be steel drums conforming with requirements of the Fed-



eral Specification ERD-729a "Drums Steel Type 5B for Liquid Petroleum Products."

Drums shall be new or thoroughly reconditioned. Drums furnished by the County shall be reconditioned by the Contractor without cost to the County. Reconditioning of the containers shall consist of stripping old paint, removing all traces of former contents and rust from the interior of the drum, welding or brazing any leaky seams or cracks and painting the outside of the drum. The Contractor will not be required to weld or braze breaks or seams in excess of 12 inches on a single container furnished by the County. Soldering of leaky containers will not be permitted.

All drums shall be painted on the bottom and sides with barrel paint of quality and color meeting the approval of the Engineer. Paints with tar or asphalt base will not be accepted. The heads of drums of hydraulic hoist oil shall be painted green.

In addition the following information shall be stenciled on the head of the drum in a waterproof ink or paint:

Producers name and address

Grade of oil and lot number

Gallons of oil contained

On the sides of all containers near the top chime shall be stenciled the grade number of the oil, the net gallons, and the year of manufacture.

**4253.07 METHOD OF MEASUREMENT.** Each container shall be filled with the specified number of U. S. Standard gallons of oil at 60°F. Volumes measured at other temperatures will be corrected to a basis of 60°F. using factors obtained from the National Standard Petroleum Oil Tables, Circular C-410, issued by the U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.

**4253.08 BASIS OF PAYMENT.** For the quantity of hydraulic hoist oil of acceptable quality, measured as prescribed above, delivered to the specified destination, the Contractor will be paid the contract price per gallon. This price shall be full compensation for furnishing all labor and material and delivering the oil with freight prepaid to the specified destination.



## Section 4254. Lubricating Oil

4254.01 GENERAL. This specification covers the grades of refined petroleum oils used for lubrication of internal combustion engines. Compound lubricating oils containing products other than those derived from crude petroleum shall be approved by the Engineer before being used in the blending of the oil.

A. Grades. The lubricating oils shall be supplied in five grades, designated as Numbers 10-W, 10, 20, 30 and 40, and shall comply with the following requirements:

Grade No.	Saybolt Viscosity Seconds at		Flash Point Min. °F.	Pour Test Max. °F.	NPA Color Not Darker Than Number	API Gravity Deg. @ 60°F. Minimum
	130°F. Max.	210°F. Min. Max.				
*10-W	120	44 47	390	-15	3	26.0
10	120	44 47	405	-15	3	26.0
20	170	53 55	420	0	4	25.5
30	225	60 63	430	5	5	25.0
40	350	70 75	440	10	6	24.5

Unless otherwise specified, the viscosity index of all grades shall be not less than 78.

\*The Saybolt Universal Viscosity of the 10-W at 0°F. shall be between 5,000 and 10,000 seconds. Viscosities at temperature other than Standard A.S.T.M. viscosity temperatures shall be determined by extrapolation or interpolation of the ASTM Viscosity-Temperature Chart D-341.

B. Neutral Stock. The neutral stock used in compounding the various grades of oil shall be straight-run stock. It shall have a Saybolt Universal Viscosity @ 100°F. of not less than 200 seconds and shall not be darker than 3 NPA Color.

C. Pour Point. The pour point of the neutral or bright stock before treatment with an approved pour depressor, shall not be more than 10°F.

D. Acidity. The acidity of any of the oils in milligrams of KOH per gram of oil shall not exceed 0.05.

E. Additive. If an additive is to be blended with the oils to improve their properties for heavy duty gasoline or diesel service, the additive shall be of the multi-functional type acting as a detergent, antioxidant, and corrosion inhibitor, and shall be specifically approved by the Engineer and it shall be compatible with the type of stocks used in compounding the oils.

The test limits listed shall apply to the oil before treatment with the additive.



**4254.02 METHODS OF TESTING.** All tests shall be made in accordance with the latest methods adopted by the A.S.T.M. for the test indicated.

**4254.03 INSPECTION.** The provisions of Article 4253.05 shall apply to inspection of lubricating oil.

**4254.04 CONTAINERS.** Containers for lubricating oil shall be 55 gallon drums. The provisions of Article 4253.06 shall apply to containers for lubricating oil, except that the heads of the drums of lubricating oil shall be painted white.

**4254.05 METHOD OF MEASUREMENT.** The provisions of Article 4253.07 shall apply to the measurement of lubricating oil, except that the volume of any additive furnished by the Commission shall be deducted from volume measured for payment.

**4254.06 BASIS OF PAYMENT.** For the quantity of lubricating oil of acceptable quality, measured as prescribed above, delivered to the specified destination, the Contractor will be paid the contract price per gallon. This price shall be full compensation for furnishing all labor and materials and delivering the oil with freight prepaid to the specified destinations.

## Section 4255. Regular Transmission Oil

**4255.01 GENERAL.** This specification covers the grades of lubricants used in transmissions and final drives of various types of trucks and tractor units where the use of an extreme pressure lubricant is not required. This oil shall be supplied in two grades, designated as "Summer transmission oil" and "Winter transmission oil," and shall comply with the following requirements:

	Saybalt Viscosity Seconds at 210°F.		Flash Point °F. Min.	Pour Test °F. Max.	Color Not Darker Than	Gravity ° A.P.I. Minimum
	Minimum	Maximum				
Winter Transmission Oil	80	90	350	-10	Light Green	21.0
Summer Transmission Oil	180	210	475	25	Light Green	19.0

The lubricant shall be free of all moisture and shall contain no artificial fillers such as talc, mica, asbestos, or other deleterious impurities.



**4255.02 METHOD OF TESTING.** All tests shall be made in accordance with the methods adopted by the American Society for Testing Materials for the test indicated.

**4255.03 INSPECTION.** The provisions of Article 4253.05 shall apply to inspection of transmission oil.

**4255.04 CONTAINERS.** Containers for regular transmission oil shall be 55 gallon drums. The provisions of Article 4253.06 shall apply to containers for transmission oil except that the heads of drums of transmission oil shall be painted yellow.

**4255.05 METHOD OF MEASUREMENT.** The provisions of Article 4253.07 shall apply to the measurement of transmission oil.

**4255.06 BASIS OF PAYMENT.** For the quantity of regular transmission oil of acceptable quality furnished, measured as prescribed above, delivered to the specified destinations, the Contractor will be paid the contract price per gallon. This price shall be full compensation for furnishing all materials and labor and delivering the transmission oil with freight prepaid to the specified destination.

## Section 4256. Extreme Pressure Transmission Oil

**4256.01 GENERAL.** This specification covers the grades of extreme pressure lubricants for hypoid gears, transmissions and differentials in various types of trucks and passenger cars. Extreme pressure transmission oil shall be supplied in two grades designated "Winter EP" and "Summer EP." The oils shall comply with the following requirements:

Grade	Saybolt Viscosity Seconds at 210°F.		Flash Point °F. Min.	Pour Test °F. Max.	N.P.A. Color Not Darker Than Number	Gravity at 60°F. "A.P.I. Minimum
	Minimum	Maximum				
Winter EP	80	90	375	-10	6	22.0
Summer EP	150	170	475	20	7	21.0

- A. The base used in compounding the lubricants shall be approved by the Engineer before being used.
- B. The color and gravity of the oils used will be determined before compounding with the EP base.
- C. In preparation, the mixture of oils and EP base shall be heated to 150°F. and agitated for not less than 15 minutes.



- D. The lubricants shall be lead free, shall contain no moisture and no artificial fillers, such as talc, mica, asbestos or other deleterious materials.
- E. There shall be no separation of the extreme pressure base from the mineral oil either while the lubricant is in storage or in use. The lubricant shall show no tendency to thicken, oxidize or foam while in use.
- F. A clean polished copper strip shall show no corrosion after being submerged in the lubricants at a temperature of 200°F. for 48 hours.
- G. When tested on the Timkin Machine at a rubbing speed of 800 r.p.m. the lubricants shall withstand a 50 pound lever load for 10 minutes. The temperature of the oil at the beginning of the test shall be 100°F. and the 50 pound lever load shall be applied in a single increment. Following the loading test on the Timkin Machine the cup and the test block shall be examined and any evidence of scuffing on either the cup or the test block will be considered failure in the test.

**4256.02 METHODS OF TESTING.** All tests shall be made in accordance with methods adopted by the A.S.T.M. for the test indicated.

**4256.03 INSPECTION.** The provisions of Article 4253.05 shall apply to inspection of extreme pressure transmission oil.

**4256.04 CONTAINERS.** Containers for extreme pressure transmission oil shall be 55 gallon drums. The provisions of Article 4253.06 shall apply to containers for extreme pressure transmission oil, except that the heads of the drums of the EP lubricants shall be painted red.

**4256.05 METHOD OF MEASUREMENT.** The provisions of Article 4253.07 shall apply to measurement of extreme pressure transmission oil.

**4256.06 BASIS OF PAYMENT.** For the quantity of extreme pressure transmission oil of acceptable quality furnished, measured as provided above, delivered to the specified destination, the Contractor shall be paid the contract price per gallon. This unit price shall be full compensation for furnishing all materials and labor and delivering the EP transmission oil with freight prepaid to the specified destination.



## Section 4260. Grass and Legume Seed

**4260.01 GENERAL REQUIREMENTS.** All seed must comply with the requirements of the Iowa Seed Law. The bidder must submit with his bid the percentage of purity and germination, and also the number and kind of secondary noxious weed seed per ounce for each kind of seed which he proposes to furnish.

The minimum requirements for purity and germination shall be as set forth in the contract documents. The percentage of germination for Alsike Clover and Red Clover will include 50% of the hard seeds. The percentage of germination for Alfalfa, Lespedeza, and Hairy Vetch shall include all the hard seeds.

The amount of other crop seeds shall not exceed 2%. Only White Dutch Clover, Alsike Clover, Red Clover, and Alfalfa seed in the above "Other Crop Seeds" will be considered in determining the purity.

The noxious weeds to be considered shall be those covered by the Iowa Seed Law.

No seed will be accepted which contains noxious weed seed in excess of the amount allowed by the Iowa Seed Law, and in no case will Alfalfa, Clovers, or seeds of that size be accepted which contain more than 3 dock or 3 sheep sorrel seeds per ounce of seed.

Methods of labelling and shipment shall be in accordance with the Iowa Seed Law.

Delivery of seed will be taken in full bags and no partially filled bags will be required.

**4260.02 SAMPLES.** Samples of the seed will be tested at the Iowa State College Seed Laboratory, Ames, Iowa, to determine the percentage of germinable seed and the amount of weed seed and other foreign seed in each shipment. Only the strong germinable seed will be considered in making these tests.

If the seed to be furnished on the contract is shipped to one central point in one lot from which it is to be redistributed, a representative of the Seed Laboratory may be sent to collect samples of same. If it is shipped direct to various points in the State of Iowa, a representative of the County will collect samples and submit same for test.

**4260.03 DETERMINATION OF LOW BID.** In comparing bids, not only will the prices be compared, but the percentage of germinable seed and purity as well as the noxious weeds, will be considered before contract is awarded.



Comparison of bids will be made as follows so far as purity, germination and price are concerned. Assume that the bidder quotes on Alsike Clover as follows:

Price.....40 cents per lb.  
 Alsike Clover 98% Purity 82% Germination

#### SOLUTION

Alsike Clover  $98 \times 82 = 80.36\%$  of pure germinable seed.

On this basis, the cost per pound for pure

germinable seed would be:  $\frac{40}{0.8036} = 49.77$  cents

**4260.04 BASIS OF FINAL PAYMENT.** The final amount paid will be based upon the percent germination and purity as shown by the laboratory test of material delivered.

Assume that in the foregoing example the laboratory test on the seed furnished under the contract is:

Purity—95.8 pure alsike plus 0.2% acceptable other crop seeds. Germination—80% plus 16% hard seeds.

Alsike Clover  $96 \times 88 = 84.48\%$  pure germinable seed.

Therefore the price paid for the Alsike Clover delivered will be

$$\frac{40 \times 0.8448}{0.8036} = 42.05 \text{ cents per pound}$$

In case the seed shows a lower test than that quoted by the bidder, the County Board reserves the right to take said seed and pay for same on the above basis.

This method will be used as a basis of payment regardless of any other rules or regulations to the contrary. It will thus be seen that the bidder is paid in direct proportion to the amount of good seed furnished.

The net amount of seed purchased and paid for under these specifications shall not include the weight of bags. The price bid shall include the cost of bags.

### Section 4272. Railroad Crossing Signs and Posts

**4272.01 GENERAL.** Railroad crossing signs shall consist of metal blades with the words "Railroad Crossing" embossed thereon arranged for mounting at an angle of 25° with hori-



zontal on a creosoted timber post. The sign blades and posts shall conform to the following requirements:

**4272.02 SIGN BLADES.** The blades of railroad crossing signs shall be 16 guage galvanized or bonderized steel, with letters and borders embossed in accordance with the design, and specifications shown on Pages 7 and 8 of Bulletin No. 3 "Railroad Highway Grade Crossing Protection" of the Association of American Railroads, Transportation Building, Washington, D. C. Letters shall be embossed with black enamel, semi-glaze finish. Background shall be enamel white, eggshell finish. Sheets of metal in each blade shall be fastened together with 8 bronze machine screws, 5/16" diameter, of theft resisting type.

**A. Reflector Buttons.** The letters of the face of the sign shall also be marked with No. 3 crystal reflector buttons inset in the metal. The number of buttons used in each word shall be as follows:

Rail	34
Road	46
Crossing	89

**4272.04 Bolts.** Bolts for attachment of blades to the post shall be 5/8" diameter N. C. thread machine bolts of sufficient length to attach the sign to 6 inch post. Bolts shall conform to requirements of Section 4220 and shall be coated on all surfaces except internal threads with a smooth and continuous coating of zinc at the rate of not less than 1 ounce per square foot.

**4272.05 Posts.** Posts for railroad crossing signs shall be Fir or Southern Pine 6" x 6" x 16' conforming with requirements for Class D lumber, Section 4139, except that fir posts shall be free of heart centers.

Before treatment the tops of the posts shall be roofed at an angle of 25° from the Horizontal (65° from centerline) and posts shall be bored with 2 holes 11/16" diameter on the centerline of the post in line with the ridge of the roofed top. Holes shall be 7" center to center and the top hole shall be 1'-8 1/2" from the top of the post.

Posts shall be given full pressure preservative treatment with creosote oil in accordance with provisions of Section 4137.

**4272.06 MEASUREMENT AND PAYMENT.** For the number of railroad crossing signs complete with bolts and of acceptable quality, the Contractor will be paid the contract



price per sign. For the number of railroad crossing sign posts of acceptable quality the Contractor will be paid the contract price per post. These unit prices shall be full compensation for furnishing all material and labor and for delivery of the items with freight prepaid to the specified destination.

### Section 4273. Wood Sign Boards

**4273.01 GENERAL.** Wood sign boards will be furnished in rectangular "boards" of the dimensions specified, or in "arrows" conforming with dimensions of the Iowa State Highway Commission plan for guide arrows.

Sign boards shall be double end trimmed to exact width and length with a planer saw. Boards may be made of two or more pieces provided the edges of the various pieces are dovetailed or are tongued and grooved together. All tongue and grooved joints shall be glued with waterproof synthetic caasin glue.

**4273.02 LUMBER.** The lumber from which sign boards and arrows are made shall be clear, well seasoned, all heart, vertical grain, Redwood, S2S to thickness of not less than 13/16 inch.

When Redwood lumber to be made into signs is purchased it shall conform to the foregoing requirements and shall be of the full width and lengths specified.

**4273.03 INSPECTION.** All sign boards, guide arrows and lumber shall be inspected after delivery to the specified destination.

**4273.04 METHOD OF MEASUREMENT.** Sign boards and guide arrows or lumber delivered will be measured by the Engineer by a count of the pieces of the various sizes specified. Lumber will be computed in thousands of board feet.

**4273.05 BASIS OF PAYMENT.** For the number of guide arrows and sign boards of various sizes conforming to the foregoing requirements the Contractor will be paid the contract price per piece.

For the thousands of board feet of lumber conforming to the foregoing requirements the Contractor will be paid the contract price per thousand board feet. These unit prices shall be full compensation for furnishing all materials and delivery of the items with freight prepaid to the specified destination.



## Section 4280. Enamels for Equipment and Metal Signs

4280.01 GENERAL. These specifications cover a single grade of primer, white and yellow enamel for use in finishing metal highway signs; a single grade of orange equipment enamel and two grades of enamel thinner.

Drier shall be added to the enamels, except rolling black (Article 4280.07) so that a brush out on a steel panel spread at 300 to 400 square feet per gallon will dry dust free in four hours and hard in twelve hours.

The enamel shall show no skinning after 48 hours in a  $\frac{3}{4}$  filled tightly closed container. The enamels shall comply with the following requirements for the respective material:

4280.02 VEHICLES. All vehicles shall conform to the following requirements for the type specified:

A. Alkyd Varnish. This specification is designed to produce an alkyd varnish, free from rosin and rosin derivatives, to be used in formulating sign and equipment enamels of maximum durability for outside exposure.

1. **Composition.** The varnish shall be of the alkyd phthalate type. The total solids shall not be less than 50.0% by weight. The solids shall be composed of not less than 25.0% phthalic anhydride and 50.0 to 60.0% soya bean or linseed oil or a combination of the two oils.
2. **Viscosity.** The varnish shall show viscosity S to V on the Gardner-Holdt Scale at 77°F.
3. **Color.** The color shall not be darker than 6 on the paint and varnish Hellige Comparator.
4. **Appearance.** The varnish shall be clear, transparent and homogeneous.
5. **Drying Time.** The drying time of the varnish shall be adjusted to meet the drying time requirement for the enamel in which the varnish will be used.
6. **Water Resistance.** A flow out film on a tin panel dried for 48 hours shall be immersed in a beaker of water for three hours. The panel shall then be removed from the water, wiped carefully, and allowed to dry at room temperature. The time required for whitening, if any, to disappear shall not exceed 30 minutes.
7. **Compatibility.** The varnish when ground with the pigments specified for the enamel shall show no ap-



preciable thickening or livering after standing 48 hours in a  $\frac{3}{4}$  filled tightly closed container at 100°F. The varnish shall be miscible with Thinner No. 10 in all proportions.

**B. Thinner No. 10.**

1. Mineral Spirits .....	90.0%
2. Xylene .....	10.0%

**C. Thinner No. 140.** The thinner for use with the orange equipment enamel shall be a naphtha conforming to the following requirements:

- 1. Appearance.** The naphtha shall be clear and free from suspended matter.
- 2. The specific gravity at 60°F./60°F.** shall not be less than 0.780 nor more than 0.815.
- 3. Distillation Range.** The initial boiling point shall not be less than 360°F. nor more than 380°F. The end point shall not be higher than 420°F.

D. Drier - Class B .....	ASTM D 600
E. Mineral Spirits .....	ASTM D 235
F. Xylene .....	ASTM D 364

**4280.03 PIGMENTS.** The pigments used in compounding the enamels shall conform to the following requirements for the respective materials:

A. Lead Chromate (Chrome Yellow and Chrome Orange) .....	ASTM D 211
B. Titanium Barium Pigment - Class A .....	ASTM D 476
C. Titanium Oxide, non-chalking type .....	ASTM D 476
D. Zinc Chromate .....	ASTM D 478
E. Asbestine .....	ASTM D 605
F. Carbon Black .....	ASTM D 561

**4280.04 PRIMER FOR METAL HIGHWAY SIGNS.**

**A. Composition.**

1. Pigment .....	50.0%
2. Vehicle .....	50.0%

**B. Pigment Composition.**

1. Titanium Barium Pigment .....	65.0%
2. Zinc Chromate .....	20.0%
3. Asbestine .....	15.0%



## C. Vehicle Composition.

1. Alkyd Varnish .....	80.0%
2. Thinner No. 10 and Drier .....	20.0%

The primer shall have satisfactory leveling and brushing properties and shall provide a satisfactory even surface without high gloss suitable for proper application and adhesion of the finish coat.

## 4280.05 WHITE ENAMEL FOR METAL HIGHWAY SIGNS.

## A. Composition.

1. Pigment .....	32.0%
2. Vehicle .....	68.0%

## B. Pigment Composition.

1. Titanium Dioxide, non-chalking type .....	100.0%
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## C. Vehicle Composition.

1. Alkyd Varnish .....	90.0%
2. Thinner No. 10 .....	10.0%

## 4280.06 YELLOW ENAMEL FOR METAL HIGHWAY SIGNS.

## A. Composition.

1. Pigment .....	32.0%
2. Vehicle .....	68.0%

## B. Pigment Composition.

1. Lead Chromate .....	100.0%
------------------------	--------

A combination of lead chromates shall be used that will, in a dry paint film, match the standard shade of Federal Yellow for Highway Signs.

## C. Vehicle Composition.

1. Alkyd Varnish .....	90.0%
2. Thinner No. 10 .....	10.0%

4280.07 ROLL-COATING BLACK ENAMEL FOR METAL HIGHWAY SIGNS. The pigment-vehicle ratio shall be such that a satisfactory coating will be obtained with one pass of the sign through the roll-coating machine. The pigment shall consist of 100.0% carbon black. The vehicle shall be a heavy bodied alkyd varnish which with the addition of drier will dry dust free in one hour and hard in four hours. The enamel shall be compatible with the No. 10 Thinner.

4280.08 ORANGE EQUIPMENT ENAMEL. Orange equipment enamel shall conform to the following:



**A. Composition.**

1. Pigment .....	40.0%
2. Vehicle .....	60.0%

**B. Pigment Composition.**

1. Orange Chrome Yellow .....	100.0%
-------------------------------	--------

A combination of orange chrome yellows shall be used that will, in a dry paint film, match the standard shade of Iowa Orange Equipment Enamel.

**C. Vehicle Composition.**

1. Alkyd Varnish .....	90.0%
2. Thinner No. 140 .....	10.0%

**4280.09 PACKAGES AND MARKING.** Enamel shall be packed in metal pails of either 1 or 5 gallons as specified in the contract. The one gallon containers shall be tinned pails with double-tite friction top lids. The five gallon pails shall conform to the Federal Specifications RRD-761, for Drums and Pails, Steel, ICC Type 5E, Single trip containers. Each container shall be plainly marked on its side with the volume in gallons and color of enamel content, the lot identification number and the name and address of the manufacturer.

Unless otherwise specified in the contract the County reserves the right to inspect all enamel as delivered. In case the County elects to inspect the enamel at the factory, the Engineer or his representative shall have free access to the plant for inspection purposes, and every facility shall be extended to him for this purpose.

**4280.11 SAMPLES FOR TEST.** Where factory inspection is to be made, before the enamel is made the manufacturer shall submit, upon request, samples of each of the ingredients of the enamels he proposes to furnish, in the amounts specified. These samples shall constitute the standards of comparison for any material supplied.

Samples required for testing purposes shall not be less than the amounts hereinafter specified. Enamels shall be mixed carefully by very thorough stirring before samples are taken. All samples shall be shipped in clean tin containers with tight fitting covers and so packed that no damage will result during transit. They shall be properly labeled and each sample shall be accompanied by a card or tag securely attached, giving full information relative to the sample.



### Quantities of Samples Required

Ready-mixed enamel .....	Not less than 1 pint
Varnish .....	1 Quart
Thinner and Drier .....	Not less than 1 pint
Dry Pigments .....	$\frac{1}{4}$ Pound

**4280.12 METHODS OF TESTING.** In testing enamel to be used under these specifications, the Standard and Tentative Standard Methods of the ASTM shall be used when applicable.

All percentages are stated on a weight basis. If upon analysis the composition of pigment and vehicle is found to be within 1.0% of the specified percentages the material will be accepted.

Drying time will be tested at an atmospheric temperature of 70° to 80°F. a relative humidity of 45 to 65 per cent and with the specified spreading rate.

**4280.13 METHOD OF MEASUREMENT.** Each container shall be packed with the desired volume in US Standard gallons at 70°F. The Engineer will determine the number of gallons of enamel delivered by a count of the containers.

**4280.14 BASIS OF PAYMENT.** For the quantity of enamel of satisfactory quality delivered to the specified destination the Contractor will be paid the contract price per gallon. This price shall be full compensation for furnishing all material and labor and delivering the paint with freight prepaid to the specified destination.



PART V.  
STANDARD FORMS

The following are the "Standard Forms" referred to herein, and these forms are applicable to all work done under these specifications.

1. Standard Form for Advertisement

Form No. 381

**NOTICE TO BIDDERS**

1. Sealed bids will be received by the Auditor of \_\_\_\_\_ County at his office \_\_\_\_\_, Iowa, until \_\_\_\_\_ o'clock, \_\_\_\_\_ M., on \_\_\_\_\_, 19\_\_\_\_, for the various items of construction work listed below.

2. A certified check, drawn upon a solvent Iowa Bank, in an amount as set forth in the proposal form, made payable to the County Auditor, shall be filed with each proposal. This check may be cashed and the proceeds retained by the County as liquidated damages if the bidder fails to execute a contract and file an approved bond for the faithful performance thereof, within ten days after the acceptance of his bid.

3. Plans, specifications and proposal forms for the work may be seen and may be secured at the office of the County Auditor.

4. All proposals must be filed on the forms furnished by the County, sealed and plainly marked. Proposals containing any reservations not provided for in the forms furnished may be rejected, and the County Board reserves the right to waive technicalities and to reject any or all bids.

5. Attention of bidders is directed to the Special Provisions covering the qualifications of bidders and subletting or assigning of the contract.

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(Engineer's Note. Insert above location of road or bridge to be improved or destination of material delivered with brief description of work to be contracted, such as mileage of road to be graded, or surfaced, with cubic yards of excavation, cubic yards of gravel to be hauled, lineal feet of various sizes of drain tile or culvert pipe to be furnished and laid, lineal feet of piling or board feet of lumber to be furnished. Also stipulate the minimum amount of proposal guaranty.)

----- 19\_\_\_\_, Board of Supervisors of \_\_\_\_\_ County  
By \_\_\_\_\_

County Auditor

**SPECIAL PROVISIONS**

Engineer's Note: Under this heading specific information regarding the work to be let should be furnished. Such information is supplementary to that given on the plans and in the Standard Specifications, and shall include:

1. The proposed division of work and a statement as to the minimum amount of work that will be awarded one bidder.
2. A complete description of location of gravel pits, or other pertinent information relative to the proposed source of surfacing material if the work to be let contemplates surfacing of any description.
3. If the proposed improvement includes grading or graveling, a statement as to which standard sections are applicable.
4. Any other information applicable to the work to be let, not shown on the plans or given in the standard specifications.

Special provisions shall be prepared by the Engineer for each letting and shall be furnished the Contractor and the Highway Commission, together with Notice to Bidders and Proposal Form.



2. Standard Form of Proposal

Form 382-C

**PROPOSAL FORM**

Type of Work..... County .....

Miles..... Project No. ....

Proposal of .....  
 (Name of Bidder)

of .....  
 (Name of Town) (State)

for work on..... Project Number..... located

To the Board of Supervisors of..... County, Iowa:

..... hereby certify that..... the only person or persons, interested in this proposal as principals; that an examination has been made of the plans, specifications, and contract form, including the special provisions contained herein, and of the site of the work, and..... understand that the quantities of work as shown herein are approximate only and are subject to increase or decrease, and further understand that all quantities of work, whether increased or decreased, are to be performed at the unit prices stipulated herein:..... propose to furnish all necessary machinery, equipment, tools, labor, and other means of construction and to furnish all materials specified, in the manner and the time prescribed, and to do the work at the prices hereinafter set out.

We further propose:

To do all "Extra Work" which may be required to complete the work contemplated, at unit prices or lump sums to be agreed upon in writing prior to starting such work, or if such prices or sums cannot be agreed upon, to perform such work on a force account basis, as provided in the Specifications.

To execute formal contract within ten days or forfeit the proposal guaranty furnished herewith.

To begin work by the date specified and to complete the same within the contract period, or to pay the liquidated damages stipulated below accruing for each calendar day elapsing after the expiration of the contract period, before completion of the work.

Division No.	Amount of Proposal Guaranty	Date to Begin	Date to Complete or Number of Working Days	Liquidated Damage Per Calendar Day

To furnish a contract bond in an amount not less than 75 per cent of contract award, as security for the construction and







3. Standard Form of Contract

Form 383

Kind of Work..... Project No. ....  
 Miles..... County .....

**CONTRACT**

THIS AGREEMENT made and entered by and between  
 ..... County, Iowa, by its Board of Supervisors,  
 consisting of the following members:.....

party of the first part, and.....  
 of....., party of the second part.

WITNESSETH: That the party of the second part, for and  
 in consideration of.....

..... Dollars  
 (\$.....) payable as set forth in the specifications  
 constituting a part of this contract, hereby agrees to construct  
 in accordance with the plans and specifications therefor, and in  
 the locations designated in the notice to bidders, various items  
 of road work, as follows:

Item No.	ITEM	Quantity	Unit Price	Amount
-------------	------	----------	------------	--------

Said specifications and plans are hereby made a part of and  
 the basis of this agreement, and a true copy of said plans and  
 specifications is now on file in the office of the County  
 Auditor under date of....., 19.....

That in consideration of the foregoing, the party of the first  
 part hereby agrees to pay the party of the second part,  
 promptly and according to the requirements of the specifications  
 the amount set forth, subject to the conditions as set forth in  
 the specifications.

That it is mutually understood and agreed by the parties  
 hereto that the notice to bidders, proposal, the specifications  
 for..... Project No. ....  
 County, Iowa, the within contract, the contractor's bond, and  
 the general and detailed plans are and constitute the basis of  
 contract between the parties hereto.

That it is further understood and agreed by the parties to  
 this contract that the above work shall be commenced on or



before the \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_,  
and shall be completed on or before the \_\_\_\_\_  
day of \_\_\_\_\_, 19\_\_\_\_, and that the time of commencing  
and completion of said work is the essence of this contract.

It is further understood that the second party consents to  
the jurisdiction of the courts of Iowa to hear, determine and  
render judgment as to any controversy arising hereunder.

IN WITNESS WHEREOF the parties hereto have set their  
hands for the purposes herein expressed to this and three other  
instruments of like tenor, as of the \_\_\_\_\_ day of  
\_\_\_\_\_, 19\_\_\_\_.

Approved:	_____ County, Iowa
IOWA STATE HIGHWAY	Party of the First Part
COMMISSION	By _____
By _____	Chairman
Date _____	By _____
	Party of the Second Part

4. Standard Form of Bond

Form No. 384

Project No. \_\_\_\_\_  
County \_\_\_\_\_

### CONTRACTOR'S BOND

KNOW ALL MEN BY THESE PRESENTS: That we, \_\_\_\_\_  
\_\_\_\_\_ of  
\_\_\_\_\_ (hereinafter  
called the Surety) are held and firmly bound unto \_\_\_\_\_  
County, Iowa, in the penal sum of \_\_\_\_\_  
\_\_\_\_\_ (hereinafter  
called the Surety) are held and firmly bound unto the Iowa  
State Highway Commission and to the State of Iowa, in the  
penal sum of \_\_\_\_\_

\_\_\_\_\_ Dollars (\$\_\_\_\_\_),  
lawful money of the United States, to the payment of which  
sum, well and truly to be made, the Principal herein firmly  
binds himself (themselves), their heirs, executors, and adminis-  
trators, and the said Surety binds themselves, their successors,  
assigns, executors and administrators, jointly and severally,  
firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, THAT  
whereas the above bounden Principal, did on the \_\_\_\_\_  
day of \_\_\_\_\_, 19\_\_\_\_,  
enter into a written contract with the Board of Supervisors of  
\_\_\_\_\_ County, State of Iowa, to \_\_\_\_\_

Copy of which contract, together with all of its terms, cove-  
nants, conditions, and stipulations is incorporated herein and  
made a part hereof as fully and completely as if said contract  
were recited at length, and

Whereas, the principal and sureties on this bond hereby agree to pay to all  
persons, firms or corporations having contracts directly with the principal



or with subcontractors, all just claims due them for labor performed or materials furnished, in the performance of the contract on account of which this bond is given, when the same are not satisfied out of the portion of the contract price which the public corporation is required to retain until completion of the public improvements, but the principal and sureties shall not be liable to said persons, firms, or corporation unless the claims of said claimants against said portion of the contract price shall have been established as provided by law.

Now if the principal shall in all respects fulfill his said contract according to the terms and tenor thereof, and shall satisfy all claims and demands incurred for the same, and shall fully indemnify and save harmless the County Board and the County from all costs and damages which it may suffer by reason of failure to do so and shall fully reimburse and repay the County Board and the County all outlays and expense which it may incur in making good any such default, then the obligation is to be void and of no effect; otherwise to remain in full force and effect.

Every surety on this bond shall be deemed and held, any contract to the contrary notwithstanding, to consent without notice:

1. To any extension of time to the contractor in which to perform the contract.

2. That the bond shall remain in full force and effect until the contract is completed whether completed within the specified contract period, within an extension thereof, or within a period of time after the contract period has elapsed and the liquidated damage penalty is being charged against the contractor.

3. To any change in the plans, specifications or contract, when such change does not involve an increase of more than twenty per cent (20%) of the total contract price, and shall then be released only as to such excess increase.

4. That no provision of this bond or of any other contract shall be valid which limits to less than one year from the completion of the contract, the right to sue on this bond for defects in workmanship, or material not discovered or known to the County Board and the County at the time such work is accepted.

5. That no provision of this bond or of any other contract shall be valid which limits to less than five years after the completion of the contract, the right to sue on this bond for defects in workmanship or materials in connection with or entering into paving or concrete work.

This bond is to be considered a performance bond and secures to the County Board and the County the right to recover from the contractor on account of material or labor entered into the work or work performed not in accord with the contract, specifications or plans. The contractor does not by this obligation guarantee to maintain the work for five years.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_\_

I hereby certify that the \_\_\_\_\_

\_\_\_\_\_ surety herein solicits insurance exclusively by salaried representatives who are paid no commission on business written.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Title

This bond approved by the Board of Supervisors of \_\_\_\_\_ County, this \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_\_

\_\_\_\_\_  
Chairman

\_\_\_\_\_  
Principal

By \_\_\_\_\_

By \_\_\_\_\_

Surety

Address \_\_\_\_\_

Countersigned by \_\_\_\_\_

Resident Commission Agent as Contemplated by Chapter 515, Iowa Code of 1946.



## 5. Standard Form of Extension of Contract Time

Form 344-C

County .....

Project No. ....

Kind of Work .....

**EXTENSION OF CONTRACT TIME**

To ..... And to .....

Contractor Surety

It appearing that it will be impossible to complete the.....  
 ..... work located .....

(Road or Bridge)

under contract dated ....., 19.....,  
 Project No. .... County, within the original contract  
 time the Board of Supervisors, ..... County, upon its  
 own motion, hereby extends the contract time.

(a) For a period of ..... days, making the new date of  
 completion ....., 19.....

(b) For a period of ..... working days, making the new  
 contract period ..... working days after ....., 19.....

(Note: Use (a) or (b) dependent upon whether contract period is in working  
 days, or definite calendar period.)

Necessity for extension of time occasioned by.....

Liquidated damages will be assessed, after .....

Date

as follows:

Extension of contract time, under conditions herein set forth,  
 hereby accepted and consented to.

By ..... By .....

Surety Contractor

This extension of time is granted with the understanding that  
 the contractor will maintain such rate of progress on the re-  
 maining work as to insure completion within the extended time  
 and contractor and surety will govern themselves accordingly.

Board of Supervisors of .....County, Iowa.

.....  
 Chairman

Dated at ....., Iowa this ..... day of  
 ....., 19.....

The granting of a ..... extension is recommended.

.....  
 County Engineer



6. Standard Form of Certificate of Completion

Form 435C

Contractor ..... County .....

Address ..... Project .....

Surety ..... Kind of Work .....  
Grading, Paving, Bridges, Etc.

Address .....

**CERTIFICATION OF COMPLETION OF WORK  
And**

Final Acceptance By Board of Supervisors of ..... County

This is to certify that the work covered by contract of.....

..... let....., 19....., and  
Date of Letting

dated....., 19....., consisting of.....  
Date contract was signed Give general description of work, and

on all classes of road work give length of project in miles.

On Road No. .... Located .....

On Project No. ....

..... County, Iowa, has been completed in accordance with the plans and specifications and is accepted by  
..... County on this ..... day of .....  
19.....

Given under our hands on behalf of and acting for said  
..... County as of the date last above written.

Signed.....

Date..... By.....  
County Engineer.

Date.....

Approved: Board of Supervisors

..... County, Iowa

By.....  
Chairman.



7. Standard Form of Material Contract

Form 122D

Project No. \_\_\_\_\_

County \_\_\_\_\_

**MATERIAL CONTRACT**

THIS AGREEMENT made and entered into by and between the Board of Supervisors \_\_\_\_\_ County, Iowa, consisting of the following members: \_\_\_\_\_

\_\_\_\_\_ party of the first part, and \_\_\_\_\_ of \_\_\_\_\_ party of the second part.

WITNESSETH: That the party of the second part, for and in consideration of \_\_\_\_\_

\_\_\_\_\_ Dollars (\$ \_\_\_\_\_), payable as set forth in the specifications constituting a part of this contract, hereby agrees to furnish f.o.b. the locations designated in the Instructions to Bidders, and within the time specified therein the various items of materials listed below as follows: \_\_\_\_\_

That at the option of the Party of the First Part, the amounts of materials may be increased or decreased within thirty (30) days from date thereof, not to exceed ten (10) per cent, without invalidating this contract.

That the Proposal, Instructions to Bidders, specific Contract and the specifications of the Iowa State Highway Commission for construction work on the Secondary Road System of date of \_\_\_\_\_, 19\_\_\_\_, covering the various kinds or classes of material herein specified, are and constitute the contract between the parties hereto, and that all material furnished shall comply with requirements thereof.

That the dates of delivery specified in the Proposal are of the essence of this contract and a failure to make delivery within \_\_\_\_\_ days from the specified date of delivery shall constitute a breach of this contract, and the Party of the First Part may thereafter purchase such material at its option, and the difference in cost, if any, between the amounts so paid



for the material and the contract price for the same, shall constitute the measure of damage to be paid by the Party of the Second Part to the Party of the First Part for such breach.

That in consideration of the foregoing, the Party of the First Part agrees to inspect all materials promptly upon delivery and to pay to the Party of the Second Part the sums as set forth in the contract promptly after the inspection and acceptance of the material.

IN WITNESS WHEREOF, the parties hereto have set their hands for the purpose herein expressed, to this and three other instruments of like tenor, this.....day of....., 19.....

..... County.  
Party of the First Part.

By.....  
Chairman.

.....  
By.....  
Party of the Second Part.



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